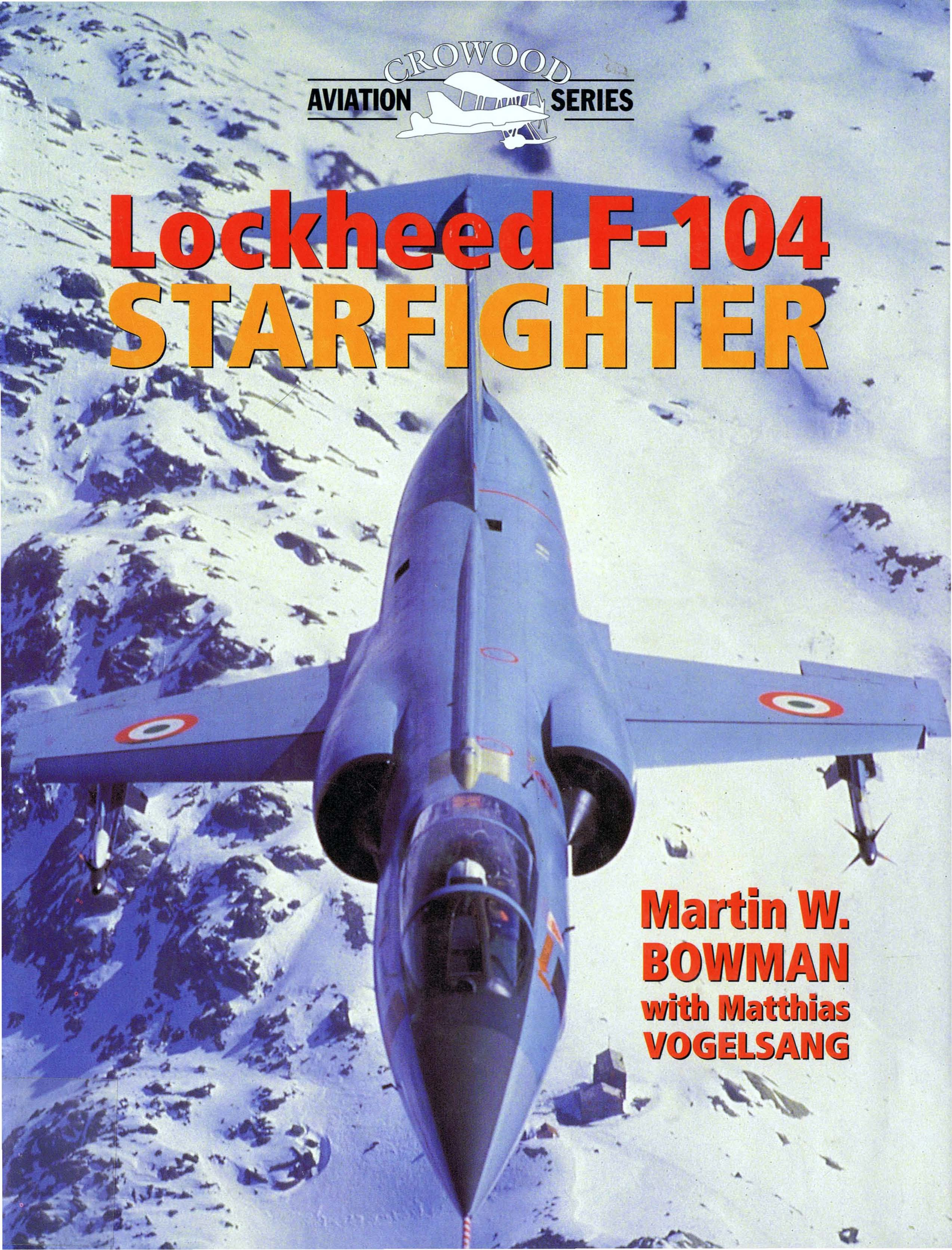
CROWOOD AVIATION SERIES

# Lockheed F-104 STARFIGHTER



Martin W. BOWMAN
with Matthias VOGELSANG

# Lockheed F-104
# Starfighter

DEDICATION

This book is respectfully dedicated to the memory of Holger Krohn of the *Marineflieger*, General Gordon Ockendon RCAF, and also to the F-104 pilots of all nations.

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## Martin W. BOWMAN
### with Matthias VOGELSANG

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Specially painted Canadian Armed Forces CF-104 Starfighters near Baden, Federal Republic of Germany, in 1986. The black-and-white chequered CF-104 (centre) is from No. 441 'Silver Fox' Squadron; the red and white CF-104 (right) is from No. 421 'Red Indian' Squadron; and the yellow-and-black striped CF-104 (left) is from No. 439 'Sabre Toothed Tiger' Squadron. In Europe CF-104/CF-104Ds were used to equip eight squadrons of No.1 Air Division, beginning in December 1962. The last CF-104s were phased out of service by No. 441 'Silver Fox' Squadron at Baden-Söllingen on 1 March 1986. CAF

# Introduction

## In the Ascendancy

In the early 1900s, Malcolm and Allan Haines Loughead, two young aviation-minded brothers in San Francisco, California, with the help of their half brother, Victor, started out on the road that was to lead two of them to form one of the biggest aviation corporations in the world. Allan Loughead, a fine engineer, aircraft designer and pilot, and newly married, returned to San Francisco early in 1912 where he resumed work as a mechanic. He managed to convince Malcolm, who for the past eight years had worked as an automobile mechanic (designing the famous hydraulic brake in the process), that they should build their own aircraft, the Model G. In 1912 they set up the Alco Hydro-Aeroplane Company from a garage at Pacific and Polk Streets in San Francisco. At the same time they continued to work as automobile mechanics to help finance the construction of the Model G.

During the summer of 1913 the Model G made four flights before it was damaged in an accident at San Mateo. Allan and Malcolm bought out the interests of their fellow investors and acquired the Model G outright. In 1913 they were forced to seek their fortune by prospecting, followed by several exciting adventures at home and abroad, Malcolm and Allan moved to Santa Barbara in 1916, and together with other investors, they created the Loughead Aircraft Manufacturing company. With the help of an architectural draughtsman by the name of John K. 'Jack' Northrop, the Lougheads built an F.1 flying boat and produced two Curtiss HS-2L single-engined flying boats. Unfortunately, both the Curtiss boats were built at a loss, a small S-1 sport biplane failed to penetrate a market dominated by war-surplus Jennies, and a Navy contract for fifty scouts was cancelled before the first aircraft was completed. In 1921, the company went into liquidation and Jack Northrop went to work for Douglas.

On 13 December 1926 the Loughead brothers and other investors formed the Lockheed Aircraft Company. Fred E. Keeler, a wealthy brick manufacturer, acquired 51 per cent of the common stock and took the title of president. Allan Loughead was vice-president. With the help of Jack Northrop, now Chief Engineer, Lockheed designed and built the trend-setting Vega cantilever monoplane, which was sold (at a loss) to George Hearst Jr., the wealthy San Francisco newspaper magnate. The company though, is best remembered for building what were arguably the fastest, finest and most sought-after monoplanes of the period from 1927 to 1934. Their unique single-shell wooden monocoque construction put their Vega and Orion cabin planes well ahead of their competitors' fabric-covered biplane designs. The speedy high-winged Vegas in the hands of accomplished trail-blazers like Amelia Earhart, Ruth Nichols and Wiley Post, completed many long-distance flights and set new speed records, while the most famous owner of a Lockheed 8 Sirius was Charles Lindbergh, who completed a number of survey flights around the world for Pan American Airways in 1930 and 1933. A Lockheed 3 Air Express won the 1929 National Air Race and a year later the same aircraft, in the hands of Roscoe Turner, set a number of new speed records.

In March 1928, meanwhile, the Lockheed company had moved its offices to the Mission Glass Works in Burbank, where four Vegas, an Air Express and an Explorer were built. (The Explorer, which was designed for long-distance record attempts, was the least successful of the early Lockheed aeroplanes. Just four were built and three crashed. The fourth was damaged and parts from this aircraft were mated to an Orion fuselage to produce the Orion-Explorer in which Wiley Post and Will Rogers were killed in Alaska on 15 August 1935.) Jack Northrop left the company three months later. He was replaced by Gerald F. 'Jerry' Vultee as chief engineer. By mid-1929, well over seventy Vegas, seven Air Expresses and the Explorer, had either been built or were under construction. Keeler realized that this was the time to make a large profit and against Allan Loughead's wishes, in July 1929, a deal was made with the Detroit Aircraft Corporation which snapped up 87 per cent of Lockheed's assets. Just three months later the Wall Street crash plunged the US into the Great Depression and many companies went into liquidation!

The Lockheed Aircraft Company was a Division of the Detroit Aircraft Corporation for two years until it too went into receivership. During this sojourn, Lockheed carried on producing Vegas, Air Expresses and Explorers, as well as building new designs, the most famous of which was the Sirius, the first being completed for Charles Lindbergh in 1929. In addition, a number of Altair and Orion aircraft were built. On 21 June 1932 at a bankruptcy court a group of investors led by Robert E. Gross, a San Francisco investment broker, bid $40,000 for the assets of the defunct company. There being no other bids, Judge Harry Holzer accepted their offer, adding, 'I sure hope you fellows know what you're doing!'. Gross became chairman and treasurer of the new Lockheed Aircraft Corporation, while Lloyd C. Stearman was elected president and general manager.

The new regime saw Lockheed move away from single-engined to twin-engined designs, the first of which was the successful Model 10 Electra transport, followed in due course, by the Model 12 Electra Junior fast executive transport. In 1936, Lockheed delivered its first military aircraft, to the US Navy, Coast Guard and AAC, and plant facilities were increased to build the Model 14 Super Electra, which would fly on 24 July 1937. Also conceived at about this time was the XP-38 (Model 22) twin-engined interceptor, which was submitted to meet AAC requirement X-608, in February 1937. Destined to become famous as the Lightning, its designers where Hall Hibbard, and 27-year-old Clarence L. 'Kelly' Johnson. Johnson had advised the company about potential instability and control problems on the Model 10 and had joined the company as a tool designer in 1933. Model 22 development was protracted with the revolutionary turbosuperchargers causing the most delays, and the XP-38 did not fly until 27 January 1939. In the meantime, Lockheed tried hard to carve a niche in the highly competitive transport market with the Model 10, 12, 14 and later Model 18, transports. There then came a breakthrough on 23 June 1938, when Britain placed an order for 200–250 Hudson aircraft.

The Second World War saw Lockheed grow enormously. On 31 March 1940, the workforce stood at 7,000 employees, and in 1941 it had risen to 16,898 personnel. Between 1 July 1940–31 August 1945 Lockheed turned out 19,077 aircraft to become the fifth largest US aircraft producer. By far the largest proportion of Lockheed-built aircraft were P-38 Lightnings, Hudsons, and Lodestars, although 500 B-17F and 2,250 G Fortresses, and B-34/37 and PV-1/-2s were produced at Burbank by the Vega Corporation (formerly AiRover Company), which was absorbed on 30 November 1943. Just over 94,300 personnel, thousands of them women engaged in building aircraft on the production lines, were working at Lockheed at this time.

## Lockheed and the Post-war Market

Post-war, Lockheed sought other markets, notably in the field of civil and military propeller-turbine and jet transports. In 1955 the Model 188 Electra turbine-powered airliner entered the design stage after American Airlines had shown their dissatisfaction with Douglas and the pricing of their DC-7 airliner by announcing that it was ready to receive bids for alternative aircraft for its hitherto Douglas-equipped fleet. On 8 June 1955, American Airlines ordered 35 Electras and on 27 September, Eastern Airlines ordered forty.

By the end of 1955 Lockheed had received orders for another sixty-one Electras. The Model 188 was completed in 26 months and flew, eight weeks ahead of schedule, on 6 December 1957. At this time the Electra was the sacred cow at Lockheed. The company in 1957 had suffered heavily from the cutbacks in defence spending in American which lost them $150 million in cancelled contracts in five months.[1] Deliveries of the Electra to airlines began early in 1959 to American but three Electras were lost in fatal accidents in fourteen months, from 3 February 1959, and Lockheed was forced to ground all 165 remaining Electras for a whole year while an expensive modification programme was carried out. Weakness of the engine mountings, which in turn caused nacelle vibration and then wing flexing, and final failure at the root, was deemed to be the cause of at least two of the accidents. Although the problem was finally overcome, public confidence in the Electra signalled its demise. The Electra was a financial disaster. Its repercussions prevented Lockheed from re-entering the commercial airliner market for ten years, although a military development, the P-3 (P3V) Orion long-range patrol aircraft, went on to achieve great success.

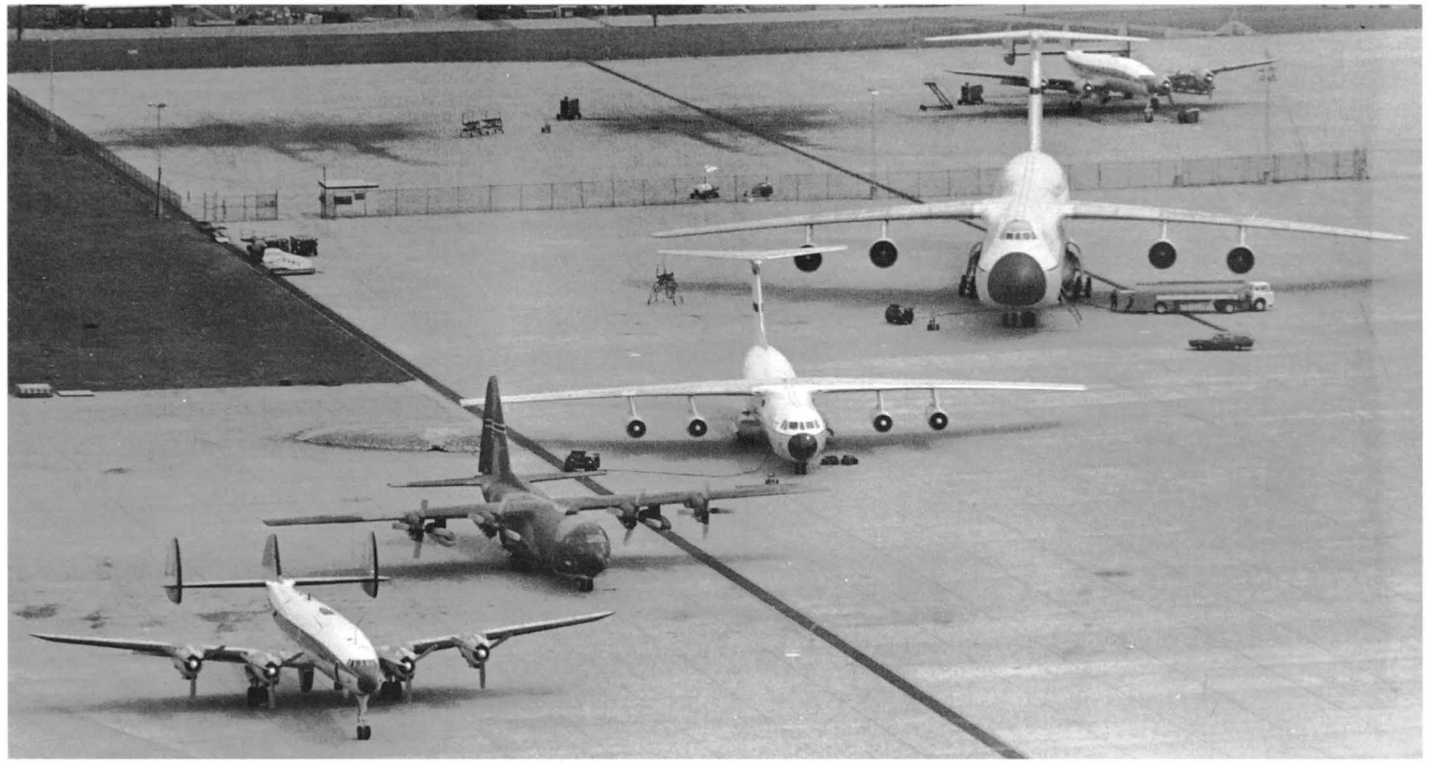
In January 1951 Lockheed had reopened a government-built plant at Marietta, Georgia, and the complex was used to build 394 Boeing B-47 Stratojets, C-130 Hercules and JetStar aircraft. The YC-130 prototype, which was to become famous as the Hercules, first flew on 23 August 1954. The type was to become hugely successful, with an eventual profit to Lockheed conservatively estimated to be roughly in the region of $300 million, while the Jetstar would continue in production until 1980. Other successes included the Constellation family of turbo-prop transports, 856 of which were turned out, and a further 1,051 P2V Neptunes. (In 1961, the Lockheed-Georgia Division was reorganized as the Lockheed-Georgia Company.)

**Designed for short and medium routes, 170 Electra 188 prop-jet aircraft were built, the first flying on 6 December 1957. Deliveries of the Electra to airlines began early in 1959 to American but three Electras were lost in fatal accidents in fourteen months, from 3 February 1959, and Lockheed was forced to ground all 165 remaining Electras for a whole year while an expensive modification programme was carried out. The Electra was quickly overtaken by the jet airliner revolution and was a financial disaster which prevented Lockheed from re-entering the commercial airliner market for ten years.** Lockheed

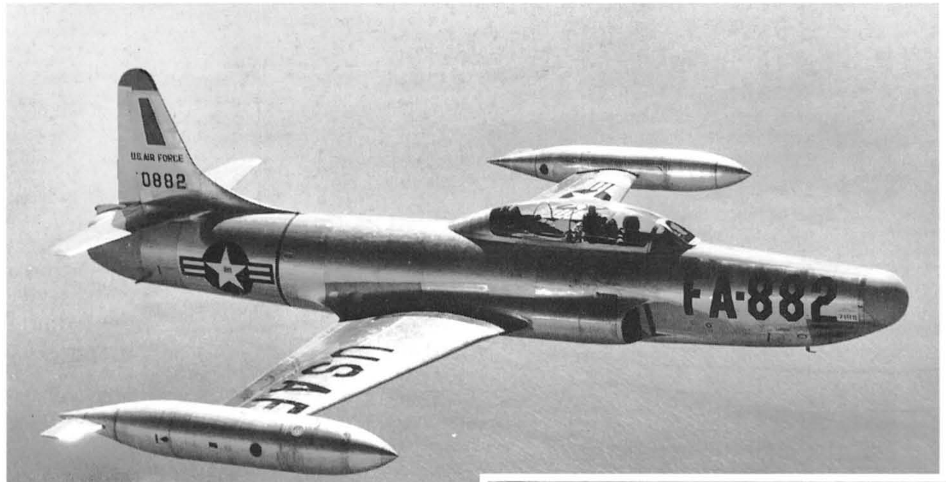
***(Below)*** **Postwar, Lockheed were successful with their four-engined Constellation family of airliners, 856 models of which were built, but when it came to the pure-jet airliner market the company failed to challenge the domination gained by the Boeing 707 and Douglas DC-8.** Lockheed

***(Above)*** **When it came to fighters, Lockheed were extremely successful post-war. XP-80-LO 44-85004 Lulu Belle, powered by a de Havilland Halford H.1B turbojet, flew for the first time on 8 January 1944, and the P-80 Shooting Star went on to become undoubtedly the most successful of all the immediate post-war jet fighters to originate during WW2, and the first to enter operational service. Altogether, 917 P-80As, 240 P-80Bs, and 748 P-80Cs were built for the USAF.** Lockheed

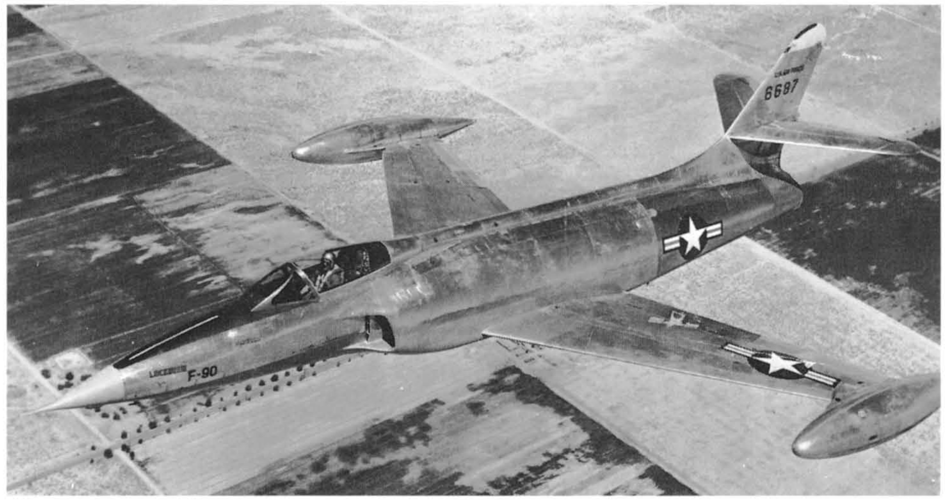
**N1649, the prototype Starliner, which flew on 10 October 1956. The type could fly non-stop from New York to any European capital and went into service with TWA on the New York to Paris route on 1 June 1957. Attempts by Lockheed to develop the Model 1649 Starliner to rival the Douglas DC-7 failed (only 43 Starliners were built) and the company urgently needed a fighter market if its 15,000 workers were not to be laid off.** Lockheed



**(Above)** Four generations of Lockheed four-engined aircraft gathered at Harrisburg International Airport, home to the Pennsylvania Air Guard's 193rd Tactical Electronic Warfare Group's EC-121S-LO electronic reconnaissance/counter measures 'Super Connies', and C-130s. These two aircraft were joined by a C-141 and the C-5 Galaxy. Lockheed

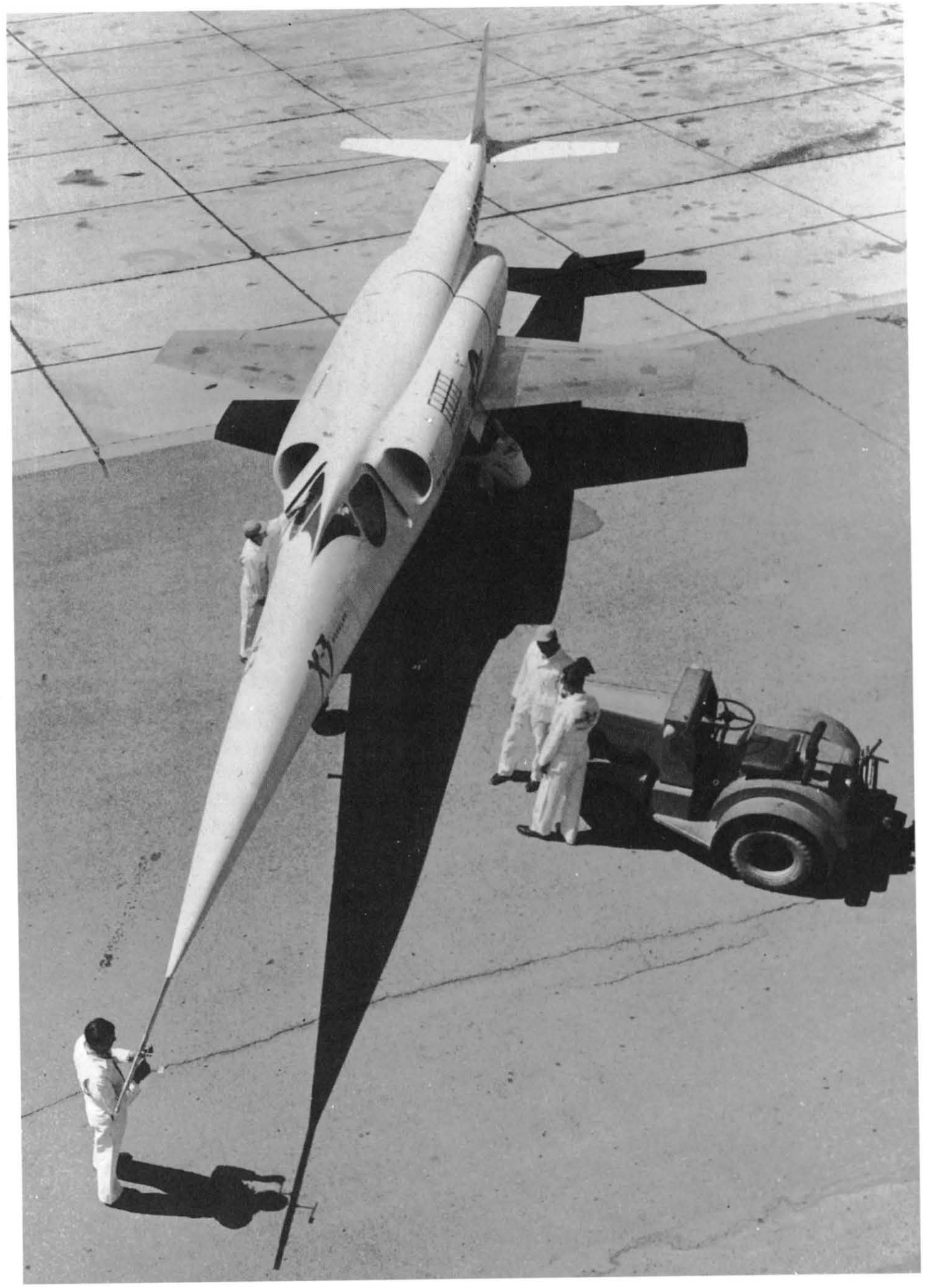


**(Left)** Responding to an Air Force request for a two-man, all-weather fighter, Lockheed strengthened the T-33 fuselage and inserted an Allison J-33A turbojet with afterburner to create the YF-94. The first of two YF94 prototypes flew on 1 July 1949, and production F-94As first entered service in June 1950. The 109 F-94As were followed by 355 F-94Bs (F-94B-1-LO 50-882, pictured). Some 279 F-94Cs followed. All told, Lockheed built 854 Starfires, 1949–54. Lockheed



The experimental XF-90 (46-687), powered by two Westinghouse XJ34-WE-11 turbojets, was designed as a long-range penetration aircraft and first flew on 3 June 1949. The needle-nosed jet lost out to the McDonnell XF-88 in June 1950 and therefore did not enter production. The XF-90, and the XFV-1 (which was designed to rise vertically), and VZ-10 (XV-4) Hummingbird VTOL aircraft fighter concepts never entered production but the XF-104 programme more than compensated for these. Lockheed

The Model 83 owed much to the 1940s' design concept of the single Douglas X-3 Stiletto (49-2892) which made its first flight on 20 October 1952 and which was built to investigate the design features of an aircraft suitable for sustained supersonic speeds. A secondary purpose of the X-3 was to test new materials such as Titanium. Particular attention was given to the problem of 'pitch-up', a phenomenon often encountered with swept-wing configured aircraft. The X-3 was powered by two Westinghouse XJ-34-WE-17 turbojets and was capable of take-off and landing under its own power. Failure of the J46 engine development programme, however, was responsible for the X-3's inability to reach its Mach 2 design objective. It had a top speed of just over Mach 1 and reached an altitude of 41,318ft (12,594m). It is currently displayed at the USAF Museum at Wright-Patterson, Dayton, Ohio. Douglas



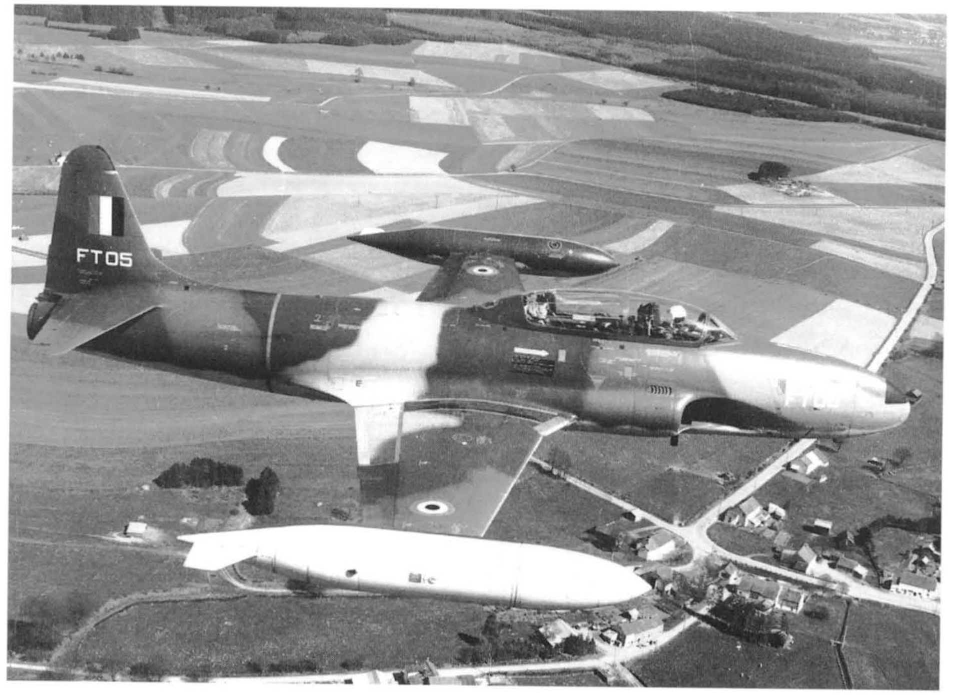
## The Skunk Works' Finest Hour?

Work on jet propulsion had started at the outbreak of war and Lockheed's first jet fighter, the XP-80, was contracted by the USAF in June 1943. At the beginning of the programme, Kelly Johnson, named chief engineer at Burbank in 1952, organized his famous Advanced Development Projects Section, which was housed in temporary accommodation next to a plastics factory. Its location earned the nickname 'Skunk Works', after the foul-smelling factory in Al Capp's 'Lil Abner' comic strip. The name stuck. (The Advanced Development Projects Section later became the Lockheed Advanced Development Company, or LADC, and in the 1990s was responsible for building the F-117A Stealth fighter.) Completed in just 143 days, the XP-80 project exemplified Johnson's credo – 'be quick; be quiet; be on time'. The P-80 became America's first production jet fighter, and by 1958 no less than 8,507 related models had been produced.

## Enter the Starfighter

Johnson and his design group then turned their thoughts to other military jets. Among the designs considered was the U-2 spyplane, and the Model 83, created in November 1952, and which finally emerged as the F-104 Starfighter. Unfortunately for Lockheed, as will become evident, although it promised much, the F-104 Starfighter was built in only limited numbers for the USAF. The first of the two XF-104 prototypes flew for the first time on 4

**Europe in the late 1950s offered American aircraft manufacturers endless opportunities to build on the sales potential gained during the late 1940s when companies such as Republic stole everyone's thunder and successfully sold aircraft to the western European democracies in large numbers. Pictured are Republic F-84G Thunderjets (which the RCAF referred to derisively as 'Lead Sleds') of the** Koninklijke Luchtmacht **(KLu, Royal Netherlands Air Force).** *KLu*



**No less than 5,641 T-33A dual-seat versions of the F-80 were built between 1948 and 1959 and 90 per cent of the free world's jet pilots were trained in the T-33. It equipped 23 friendly powers (about 1,058 aircraft), including several air forces in NATO. T-33A-1-LO (FT-05) of the** 11ème Escadrille (11 Smaldeel)**, the Instrument Squadron of the** Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu) **pictured). Sales of this aircraft were to help open the market for the Starfighter in Europe.** Lockheed

March 1954. Seventeen YF-104As followed but service deliveries of the F-104A were not finally begun until January 1958. Then they were grounded for three months while problems with the engine were rectified. By December 1958 the USAF had cut back its F-104 orders from 722 to only 296.

Air Defense Command (later Aerospace Defense Command) accepted only 179 F-104A/-B Starfighters and fairly quickly phased out the aircraft to make way for the more heavily armed McDonnell F-101B Voodoo and Convair F-106A Delta Dart all-weather fighters. The only other Starfighter versions to serve in the USAF were seventy-seven F-104Cs and twenty-one two-seat F-104D Starfighters, which were accepted by Tactical Air Command during 1958–59.

A spate of losses in US service did not help the Starfighter's cause. By the time the F-104 had logged its 100,000th flight hour, in April 1961, 49 out of 296 Starfighters operated by the USAF had been lost and 18 pilots killed – none of them in combat. In Vietnam, 1965–67, eight F-104C Starfighters were lost in action and another six were destroyed in operational accidents. The F-104C too was soon dispensed with.

The Starfighter's failure to enter wide-scale production was tantamount to another disaster for Lockheed, certainly one on the same scale as that of the failure of the Electra. Lockheed needed to sell between 2,500 and 3,000 F-104s to maintain profitability and unlike the P-3 Orion spin-off, there seemed little likelihood of a spin-off this time, for the F-104. Yet, unlike the situation with the Electra, where Lockheed had borne not only the enormous costs of the research and development programme, but had also funded the expensive LEAP (Lockheed Electra Action Program), the US government had funded the greater part of the multi-million dollar F-104 programme. However, previous attempts by Lockheed to develop a successful commercial aircraft (Starliner) to rival the Douglas DC-7, and a pure-jet airliner to rival the Boeing 707 and Douglas DC-8, had both ended in failure, so the company urgently needed a fighter market if its 15,000 workers were not to be laid off. Almost as importantly, an alternative market had to be found if the company was to remain part of the 'Big Three' with rivals Boeing and Douglas. All hopes therefore rested on marketing and selling the Lockheed military design to customers overseas.

## The Sale of the Century

Salvation for both Lockheed and the Starfighter was provided by the German Federal Republic where re-equipment of the *Luftwaffe* was needed to help counter the growing Communist threat in the east. Equally importantly, West Germany wanted to become a fully paid-up member of the 'nuclear club'. The Defence Committee had, since late 1958, been evaluating designs for a primary all-weather fighter-interceptor, fighter-bomber and photographic reconnaissance aircraft. With no aircraft industry of its own, Germany looked to France, Britain and the USA for possible fighter designs to replace the Republic F-84F Thunderstreak in the strike role, the North American F-86 Sabre in the air defence role, and the Republic RF-84F Thunderflash in photo-reconnaissance. All of these aircraft were obsolescent when they were first purchased and the *Luftwaffe* had looked to replace them even before the last of the American-equipped *geschwaders* had been activated.

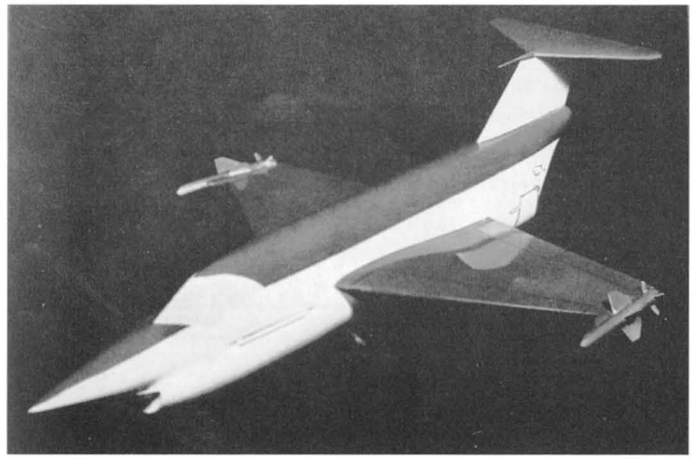
On 18 March 1959 Herr Franz Josef Strauss, who since 1956 had been Federal German defence minister, announced that 'after evaluating nearly two dozen of the world's top fighter aircraft', he had signed a contract for 96 Starfighters [32 two-seat F-104F trainers and 66 single-seat F-104Gs]. His decision to buy the F-104G – at that time an unproven multi-mission aircraft – provided the momentum for what was to become known as the 'sale of the century'. The Starfighter would not only replace the F-84F Thunderstreak, F-86 Sabre and RF-84F Thunderflash in *Luftwaffe* service, it would also replace the Hawker Sea Hawk in the *Marineflieger*, even though the German Navy had preferred the British Hawker Siddeley Buccaneer, which was considered a superior aircraft in this role, especially for low-level offshore sorties. It was tantamount to a double body blow for the British, who earlier had lost any chance of success when the government, in its wisdom, decided to relegate the superlative English Electric Lightning Mach 2+ interceptor to the background and instead tried to promote the Saunders Roe SR.177.

At first, West Germany showed a very keen interest in the SR.177 (an operational development of the SR.53 research aircraft powered by a Gyron turbojet and a Spectre rocket motor for high-altitude boost), but it was cancelled in Britain's infamous 1957 Defence White Paper. The English Electric Lightning was a more capable aircraft and did not have the very severe operational limitations of the Lockheed machine. The Lightning's ability to manoeuvre with the best and outclimb all of them gave its pilots an advantage which set them apart from others. The F-104 Starfighter had, eventually, the same straightline top speeds but it could never match the Lightning's rate of turn at any speed. It was not until the F-15, 15 years later, that the Lightning had any real competitor. In a case of what might have been, the only Lightnings ever to operate from German soil were two RAF Lightning interceptor squadrons.

## More Starfighter Orders Follow

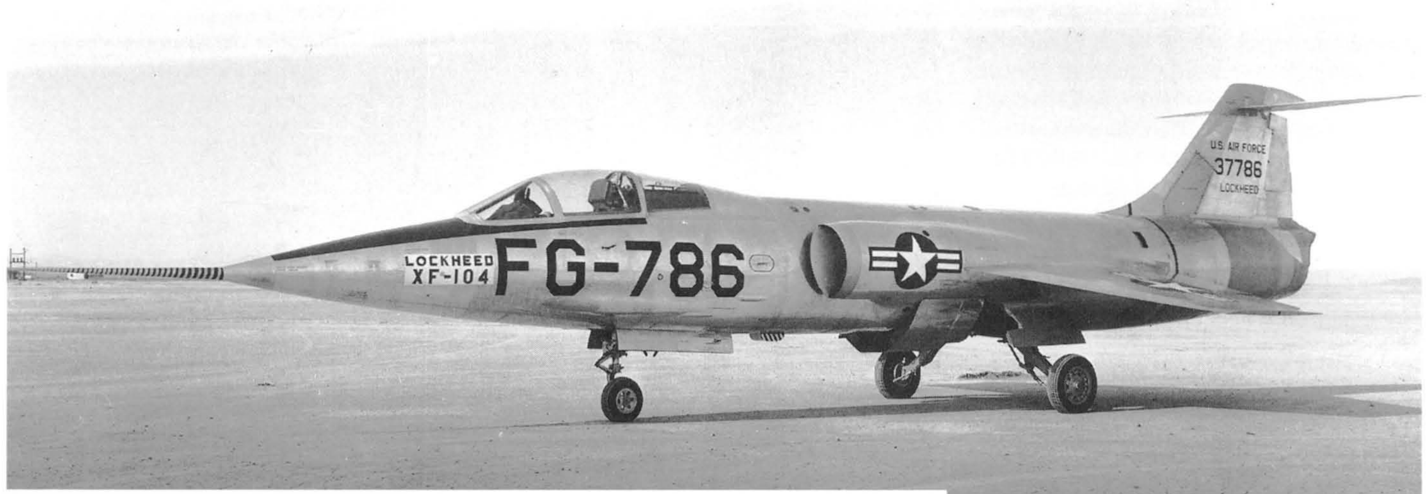
Apart from the lucrative sale of the aircraft, a complete re-design involving an almost indeterminate number of costly ECPs (equipment change proposals) would have to be carried out if the Starfighter was to come anywhere near to achieving its multi-mission role. Better still, these would be carried out by Lockheed or its licensees and paid for by the customer(s). Lockheed were also well aware that where West Germany led, the other European nations – The Netherlands, Belgium, and Italy – would follow. First of these to put pen to paper was Holland, which badly needed a replacement for its ageing *Kaasjagers* (cheese fighters) as their F-84 Republic Thunderstreaks were known.

After rejecting the Northrop N-156F (F-5 Tiger), Convair F-106 and Republic F-105 Thunderchief in September 1959 (because they were considered too heavy and too expensive) and after the elimination of the



***(Above)*** **Britain's once powerful aviation industry fared disastrously in the race to re-equip the** Luftwaffe **and the** Marineflieger**, losing out right across the board to the Starfighter in** Luftwaffe **service, and in** Marineflieger **service, where though the German Navy preferred the Hawker Siddeley Buccaneer, replacement of the Hawker Sea Hawk went also to the F-104G. Britain lost any chance of success with the English Electric Lightning Mach.2+ interceptor when the Government instead championed the Saunders Roe SR.177 (pictured). This never left the drawing board, and it was one of several promising designs which were cancelled in Britain's infamous 1957 Defence White Paper that declared all manned aircraft obsolete!** SARO

***(Above Right)*** **Herr Franz Josef Strauss (left), Federal German defence minister, the man responsible for signing the 'sale of the century' on 18 March 1959, when he signed a contract to begin licence production of the F-104G Starfighter, and** Inspekteur de Luftwaffe**, Gen Josef Kammhuber (right) during the ceremony, in August 1961, on the occasion of the delivery of the first F-104Gs built by Lockheed for the** Bundeswehr. Via Fairchild-Dornier



*(Above)* **The Starfighter success story began with two XF-104-LOs (Model 083-92-01) (53-7786, pictured and 53-7787), the designation applied to the two single-seat tactical fighter prototypes, ordered on 12 March 1953. The first flight, with non-afterburning engine, took place on 4 March 1954.** Lockheed

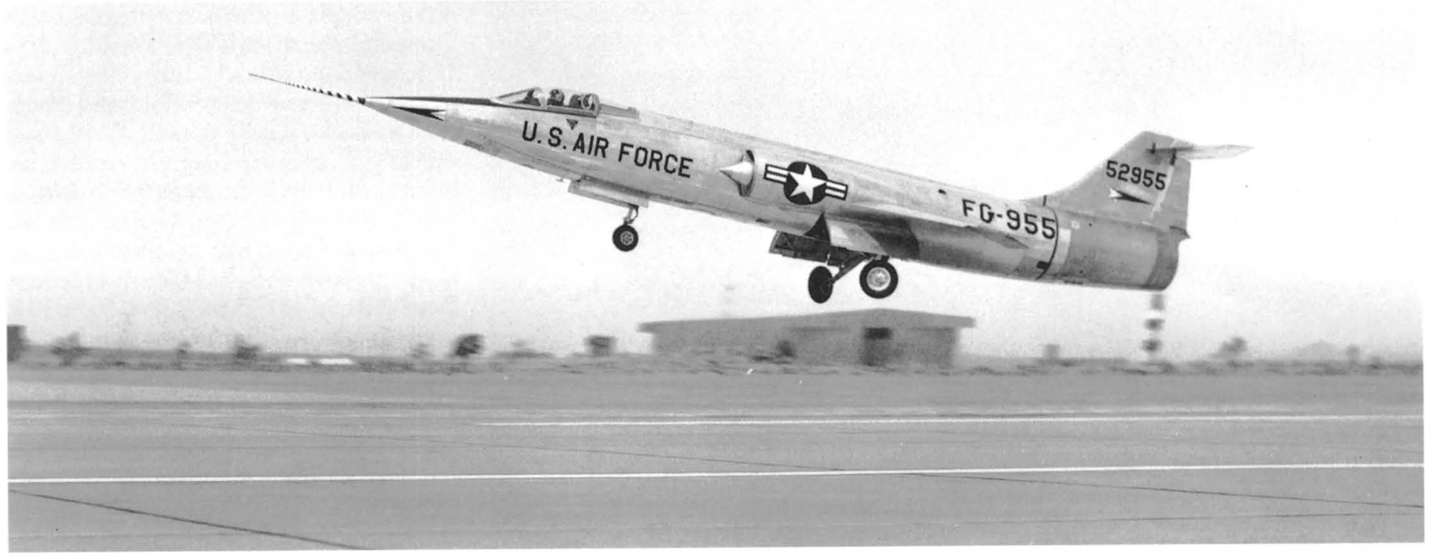
*(Left)* **Lockheed's chief engineering test pilot, Herman R. 'Fish' Salmon prepares to take the XF-104 aloft.** Lockheed

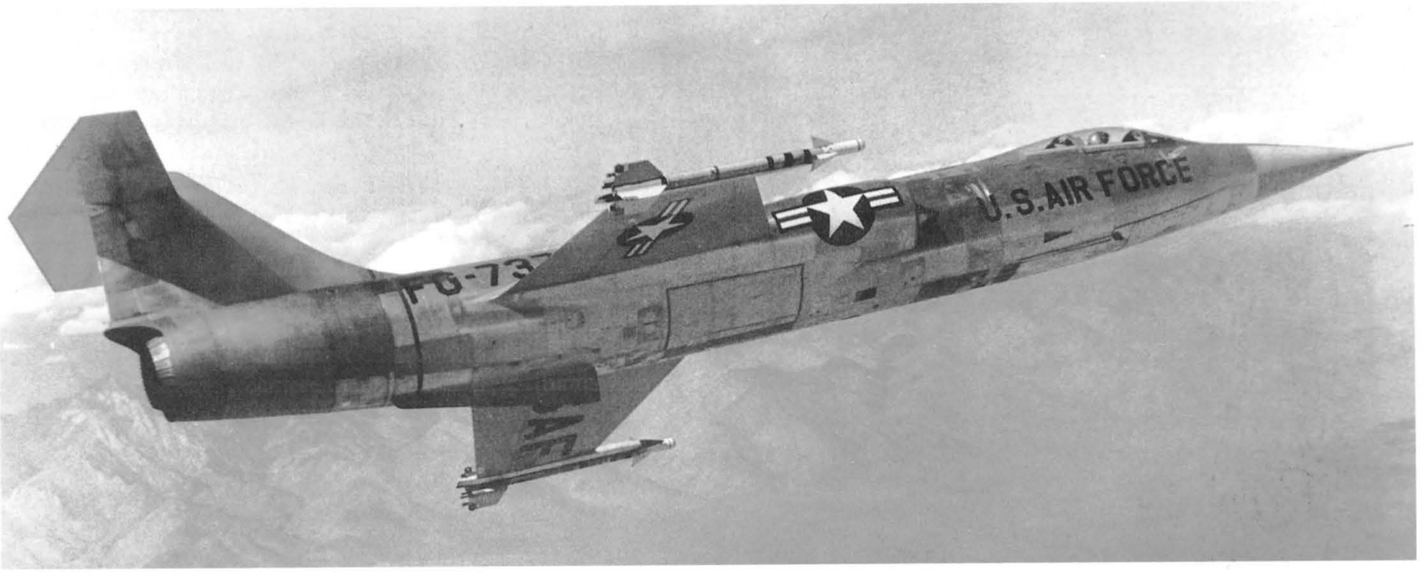
**(OPPOSITE PAGE)**

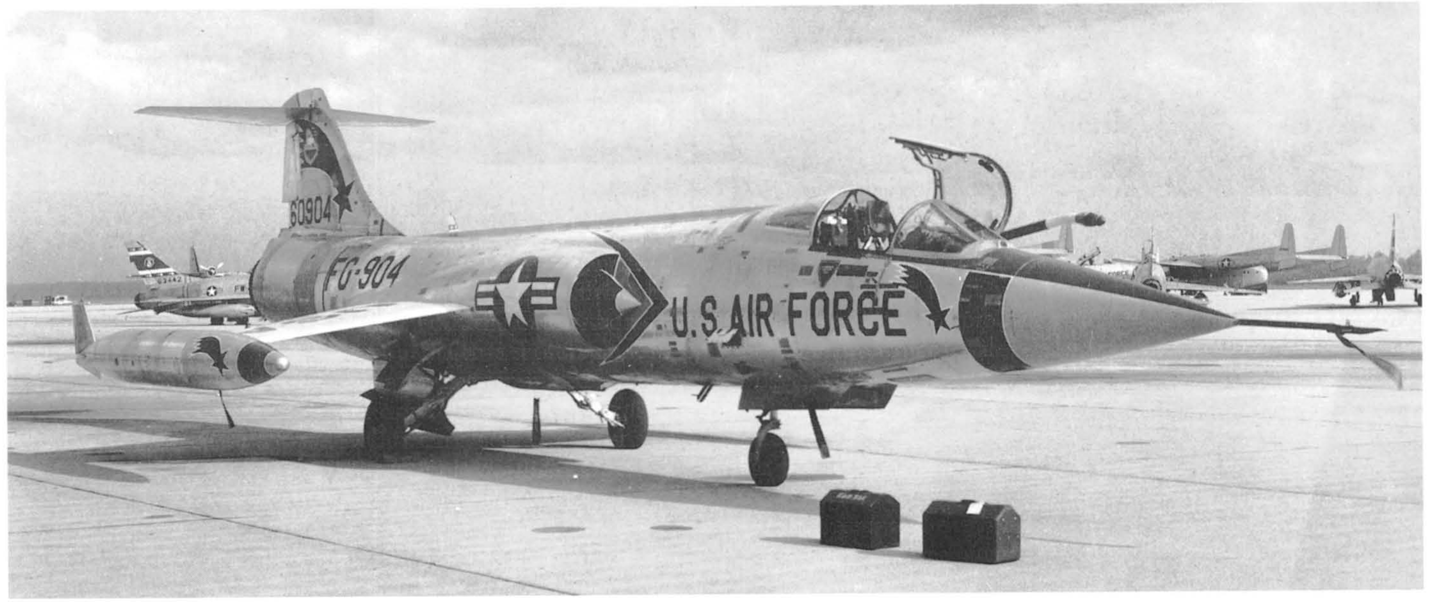
*(Top)* **The XF-104s were followed by a batch of seventeen YF-104As (Model 183-93-02) 55-2955/55-2971) built for service trials with the General Electric J79-GE-3 engine. Mach 2 was achieved in a YF-104 on 27 April 1955.** Lockheed

*(Middle)* **F-104A-5-LO (Model 183-93-02) 56-737 of Air Defense Command in flight. Deliveries of the F-104A to the 83rd Fighter-Interceptor Squadron at Hamilton AFB, California, began on 26 January 1958. In its first year of service with the USAF the F-104A Starfighter became the first operational interceptor capable of sustained Mach 2+ speeds.** USAF

*(Bottom)* **The single seat F-104C tactical strike version and two-seat F-104D, were developed for use by Tactical Air Command and deliveries of 77 F-104C (F-104C-5-LO 56-904, pictured) were made, 16 October 1958 (to the 831st Air Division at George AFB, California) – June 1959. On 14 December 1959 an F-104C took the world altitude record to 103,389ft (31,513m).** Lockheed





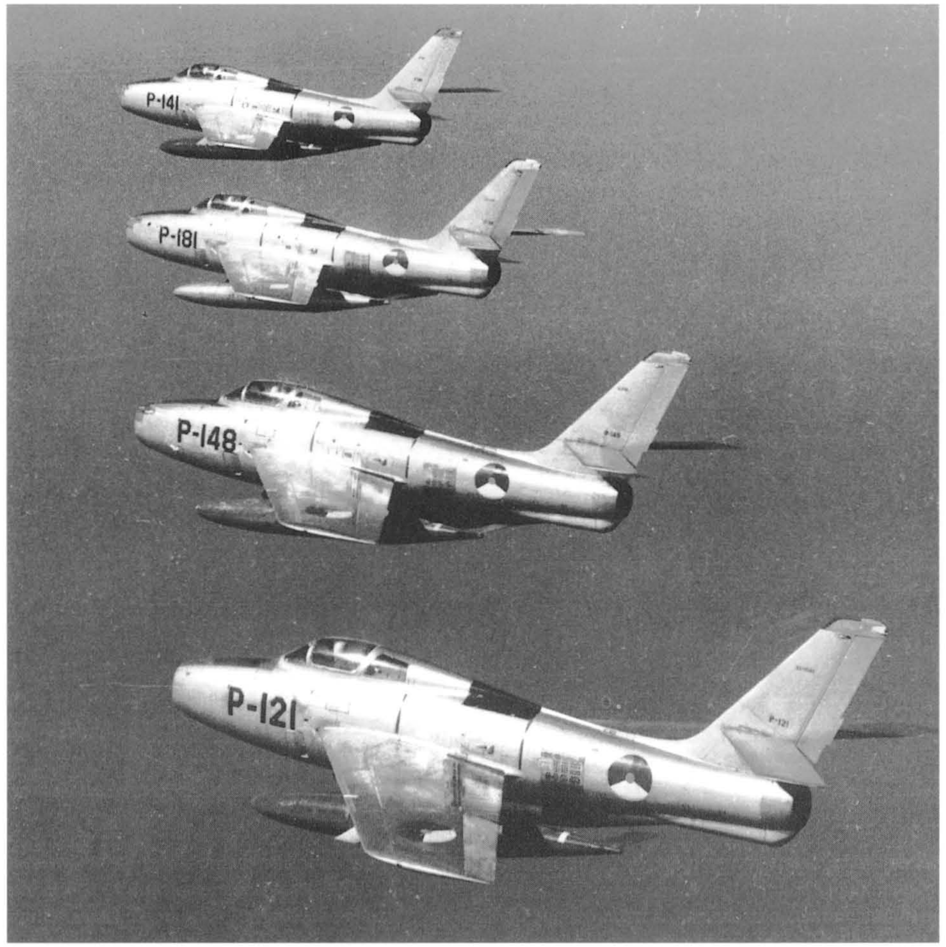


Dassault Mirage III, on 20 April 1960 the Netherlands placed an initial order for 100 Starfighters, twenty-five of which would come free from the US Military Assistance Program (MAP) budget. The Netherlands had hoped to receive 100 aircraft as part of MAP, to which they proposed to buy a further 100 aircraft by direct purchase. However, when the US government refused to improve the number of MAP-funded aircraft, and then decreed that the offer was conditional on Italy being co-opted into the F-104 consortium, the Netherlands reduced their purchase from 100 to 95 Starfighters.[2]

Belgium followed on 20 June 1960. In February 1961 the US Air Force signed the order for MAP F-104Gs. (In June 1962 the US Air Force ordered additional MAP F-104Gs.) In a move which committed virtually all the resources of the Italian aviation industry, on 2 March 1961 Italy signed a licence production contract to build the F-104G. Some 916 Starfighters were eventually acquired for the *Luftwaffe* and *Marineflieger*, 652 of them licence-built in Europe. Altogether, the Netherlands ordered 144 Starfighters, Italy, 155, and Belgium, 100.

Meanwhile, on 17 September 1959 Lockheed concluded a contract with Canadair for the Canadian company to build 200 CF-104 Starfighters to equip its eight RCAF squadrons in NATO (in 1962 another 140 F-104Gs were for re-export under the US Military Assistance Program).

In 1959 it looked as if Japan would buy American too, but its service chiefs were known to favour the Grumman F-11A Super Tiger. However, before the National Defence council formally approved the choice, Lockheed, and some influential Japanese politicians who favoured the Starfighter, made much of the aircraft's 1958 and 1959 world altitude and speed records and lobbied hard for F-104 acceptance. Ironically, one of the Lockheed Starfighter's greatest supporters was General Minoru Genda, who in July 1959 became the new chief of air staff. Genda was the man who eighteen years earlier had planned and executed the surprise attack on Pearl Harbor in Hawaii, on 7 December 1941! Genda visited Lockheed in California and, at this own request, flew a Starfighter. He declared it to be the best fighter the world had ever seen. It was now clear to Lockheed that the Japanese would buy the F-104 and not the F-11 Super Tiger. A few months later Genda was awarded the Legion of Merit by the USAF. On 29 January 1960 Japan signed a licensed production contract. In November Japan announced plans to equip its new Japan Air Self-Defence Force with 230 F-104Js in the air-superiority role.



**Republic F-84F-5IRE Thunderstreaks of the** KLu. **After Germany had opted for the Starfighter to replace its ageing Republic F-84F Thunderstreaks in the strike role, the North American F-86 Sabre in the air defence role, and the Republic RF-84F Thunderflash in the photo-reconnaissance role, The Netherlands, Belgium, and Italy followed suit. The Royal Netherlands Air Force, like Germany, badly needed a replacement for its ageing** Kaasjager **(cheese fighters) as their F-84F Thunderstreaks were known.** RNLAF

***(Below)* Republic F-84E Thunderjet of the** Kongelige Norske Luftforsvaret (KNL, **Royal Norwegian Air Force).** KNL

**Republic RF-84F-21RE Thunderflash photo-reconnaissance aircraft of the** Koninklijke Luchtmacht (KLu, **Royal Netherlands Air Force).** RNLAF

**F-84F Thunderstreaks and RF-84F Thunderflash photo-reconnaissance aircraft of the AMI (Italian Air Force).** AMI

## The Multinational Programme

All told, Starfighters were produced by manufacturers in seven countries. In Europe a multinational programme carried out the manufacture of 996 F-104G/RF-104G Starfighters, led by Messerschmitt, who were to be the major corporate partner for Lockheed until the F-104 was phased out in both the German Air Force (*Luftwaffe*) and Navy (*Marineflieger*). The Starfighter licence production was the first major order for the German aircraft industry since the Second World War. The European consortium employed up to 100,000 staff who worked in Starfighter production.

*ARGE (Arbeitsgemeinschaft)-Süd* (Work Group South), near Munich in Germany, which was made up of Messerschmitt at Augsburg; Heinkel at Speyer; Dornier at Munich; and Siebel at Donauwürth, built 210 F-104Gs for the *Luftwaffe* and *Marineflieger*. (Later, to replace losses, MBB (Messerschmitt-Bolkow-Blohm), built a further fifty F-104Gs for the German forces).

Starfighter production commenced at the German plants on 1 December 1960. Messerschmitt was responsible for production flight testing and final assembly (carried out at Manching), painting, construction of the pilot seat, the fuselage, empennage and the installation of the powerplant. Siebel initially manufactured the canopy, the electronics bay hatch cover, the escape hatch, the nose landing gear doors, the fuel tank cover and the hydraulic access door, and were responsible for the fuselage nose, the radome nose assembly, air scoops and the rear fuselage.

Dornier constructed the mid-fuselage panels, upper panel assemblies for the fuselage, the mid-fuselage side panels and the nose landing gear. Heinkel were initially responsible for the main landing gear and the droppable fuel tanks, and manufactured the main landing gear doors, dive brakes, wings, fins, rudders, horizontal stabilizers and other minor equipment. As production intensified other manufacturers in Belgium, Germany and The

Lockheed faced stiff competition from other American manufacturers when continental NATO countries looked for a successor to their ageing fleets of Thunderstreaks and Thunderjets. One of the main contenders was the Grumman Super Tiger II. Grumman

*(Below)* On 25 November 1958 the P.1B prototype (XA847), powered by two 11,250lb (5,103kg) Rolls-Royce Avons, became the first British aircraft to fly at Mach 2. The Lightning (pictured here behind RCAF CF-104 12840) became the RAF's first single-seat fighter capable of exceeding the speed of sound in level flight when delivery began of three pre-production P.1Bs to the AFDS (Air Fighting Development Squadron) at RAF Coltishall, Norfolk, in December 1959. The Lightning doubled the performance of the then-best (Hunter) RAF fighter in front-line service. It was lightly armed, with only two Firestreak air-to-air infra-red guided weapons and two Aden cannon, but its ability to manoeuvre with the best and outclimb all of them gave its pilots an advantage which set them apart from others. The F-104 Starfighter had, eventually, the same straight-line top speeds but could never match the Lightning's rate of turn at any speed. It was not until the F-15, 15 years later that the Lightning had any real competitor. Des Jennings

Netherlands assumed the manufacture of some of these items. The intense preparation for production – organizing trained staff and importing materials, tools, and manuals – was supported by Lockheed.

*ARGE Nord* (Work Group North) at Schiphol, Amsterdam, which consisted of Fokker, and Aviolanda, at Dordrecht, in the Netherlands, and the German manufacturers, Hamburger Flugzeugbau (HFB), at Hamburg, Weserflugzeugbau, and Focke-Wulf at Bremen, built 254 F-104Gs and RF-104Gs for Germany's *Luftwaffe* and *Marineflieger*, and 96 F/RF-104Gs for the *KLu* (Royal Netherlands Air Force). Fokker was responsible for production flight testing, installation of the powerplant, painting, the installation of 'loose' equipment, construction of the pilot seat and final assembly. Fokker also manufactured the electronics bay hatch cover, escape hatch, after fuselage, wing, empennage, horizontal stabilizer, fin, rudder, and, for all three European programmes, the droppable fuel tanks.

Aviolanda built the F-104G's fuselage nose, radome, fuselage, canopy, nose and main landing gear doors, canopies and fuel tank covers for all three programmes. Hamburger manufactured the windshields for all three programmes and the majority of fuselage panels for the Dutch programme. Wesser made mid-fuselage panels for the Dutch programme. Focke-Wulf built the hydraulic access doors, scoops and ducts for the same programme.

West Group (actually a geographical misnomer), at Gasselies, Belgium, which comprised Avions Fairey S.A. and SABCA (*Société Anonyme de Constructions Aéronautiques*), built 187 F-104Gs (100 for the Belgian Air Force, and 87 for the *Luftwaffe/Marineflieger*) using fuselage nose radomes. Air scoops, ducts and aft fuselage sections built by Siebel, and dive brakes, main landing gear doors, horizontal stabilizers, fins and rudders, manufactured by Heinkel, and nose landing gears made by Dornier.

The Italian Group at Turin-Caselle, made up of Fiat, Aerter, Macchi, SIAI-Marchetti, Piaggio, and SACA, built 329 F/RF-104G and F-104S Starfighters (124 F-104Gs and 205 F-104S aircraft for the *AMI* (Italian Air Force); fifteen F-104Gs and thirty-five RF-104Gs for Germany; twenty-five F-104Gs for the *KLu* (Royal Netherlands Air Force); and forty F-104S aircraft for the *Türk Hava Kubbrylrti* (*THK*, Turkish Air Force).

To co-ordinate the entire multinational production programme the NATO Starfighter management office (NASMO) was established in Koblenz, West Germany. It was here that the Bavarian Motor Works (with *Fabrique Nationale* in Brussels), manufactured the J79-GE engine under licence for the Starfighter programme.

## Starfighters in Service

The Starfighter went on to equip no less than fifteen air forces. Starfighter production (less the two XF-104, 17 YF-104A preproduction models) eventually reached 2,559. Lockheed-California built 741 of these, the most widely used Mach 2 fighter aircraft ever built. The jet's career though, was marred by a very high loss rate. Forty-nine out of 296 Starfighters operated by the USAF were lost and eighteen pilots killed, and in 1960 the type was withdrawn from Air Defense Command. In SE Asia, eight F-104s were lost in action and another six were destroyed in operational accidents before the type was phased out of theatre.

The F-104 suffered an even higher accident rate in NATO service. In 1961, when the *Luftwaffe* first put the Starfighter into service, the loss rate was eighty per 100,000 hours flown. By 1962 it had risen to 139. In 1963, though the loss rate per hour dropped because many more hours were flown, the number of accidents actually increased. By 1965 there had been a Starfighter write-off every ten days. Most alarming of all was the number of pilots killed flying Starfighters.

In 1965 the German Air Ministry asked Martin-Baker Aircraft Co. Ltd, the world famous English ejection seat company, if they could supply a rocket seat which could cope with zero/zero conditions, on the level and at an angle of 30 degrees. The Germans had already acquired some F-104s fitted with rockets with sufficient power to lift them into the air and keep them there until they reached flying speed. Martin-Baker completed some successful tests in England using an F-104 fuselage and these were followed by demonstrations in Germany. The series of tests completed later successfully demonstrated the superiority of the Martin-Baker seat, and the Germans specified the Mk.7 seat for retrofit in their F-104s. This marked the culmination of a protracted and often acrimonious debate, much of it conducted publicly, about the respective merits of the Martin-baker seat and the Lockheed C-2 seat already installed in German F-104s.

In the summer of 1959, the German Ministry of Defence had stated their preference for a Martin-Baker seat for their F-104s rather than the Lockheed seat, and James Martin[3] had agreed to develop a version of the Mk.5 seat, which the Germans had already accepted for retrofit in the F-84F, RF-84F, T-33, Sabre 6 and F-86K, for the F-104. Lockheed were understandably hostile to this suggestion and made great efforts to have their C-2 seat accepted and to promote the problems, which they maintained were insurmountable, of installing a Martin-Baker seat into an aircraft which had not been designed to take it. Lockheed, however, were forced to

On 17 September 1959 Canada followed with a contract for 200 Canadair-built CF-111 (later redesignated CF-104) Starfighters (basically similar to the Lockheed F-104G Starfighter), for the Royal Canadian Air Force. F-104A-15-LO 56-770 went to the RCAF as 12700 to act as a pattern aircraft for the Canadian Starfighter. The first Canadair CF-104 was airlifted to Palmdale, California, where it was first flight tested by Lockheed on 26 May 1961. Canadair went on to produce 150 F-104Gs for MAP for allotment to NATO air arms. Pictured in this lineup are: Canadair-built F-104G (MAP) 64-17770, USAF F-104A-20-LOs 56-790 and 56-801, and Fiat-built F-104Gs DA+101/04 (KC-101/104) for the Luftwaffe. At the far end is the Lockheed-company owned DC-3 N18565, fitted with an F-104 needle nose for trials of the Starfighter's radar and electronics. Lockheed

place a development order with Martin-Baker and the prototype seat was successfully tested by Lockheed up to a speed of 700 knots on their sled test facility.

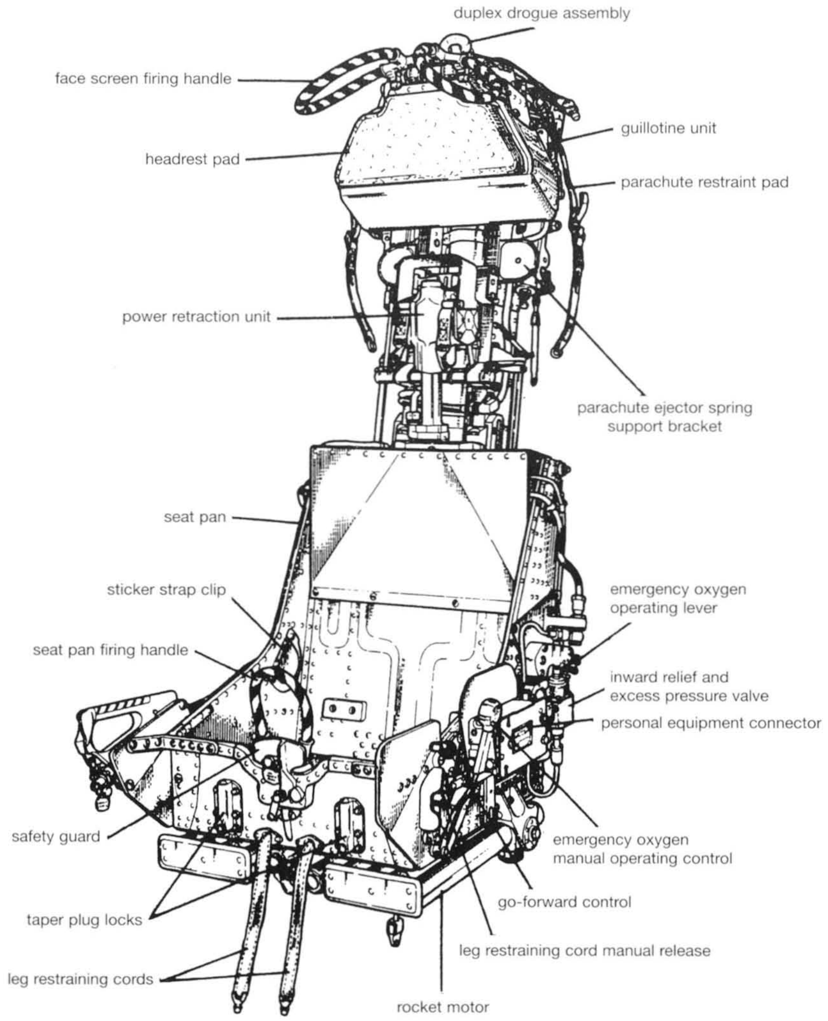
An order for production seats was placed but, during the flight trials of the aircraft, the Lockheed pilots made complaints about the Martin-Baker seat in relation to the sitting position, proximity to the instrument panel and the accessibility of certain instruments. Martin-Baker presented proposals to overcome these problems which Lockheed confirmed in February 1961 would remedy the complaints, but at a further meeting in March of that year to discuss the Martin-Baker proposals and the alternative Lockheed proposal to reinstall the Lockheed seat which they had originally offered for this aircraft, the committee expressed no interest in seeing the modified Martin-Baker seat. The C-2 was installed instead and the order with Martin-Baker was cancelled even though delivery of seats had already commenced.

A very public debate about this decision took place over the ensuing years, fuelled by inaccurate and derogatory comments about the Martin-Baker seat which outraged James Martin and which he insisted should be corrected, and by the number of fatalities arising from the use of the C-2 seat. With the introduction of rocket motors, the Mk.5 seat could now be upgraded. By that time the performance of the Martin-Baker rocket seats had been verified by their extensive test programme and by the first emergency ejections using them, and the decision to retrofit the German F-104s was announced in March 1967.[4] (By 1967 the *Luftwaffe* had lost 66 F-104s and 37 pilots killed.)

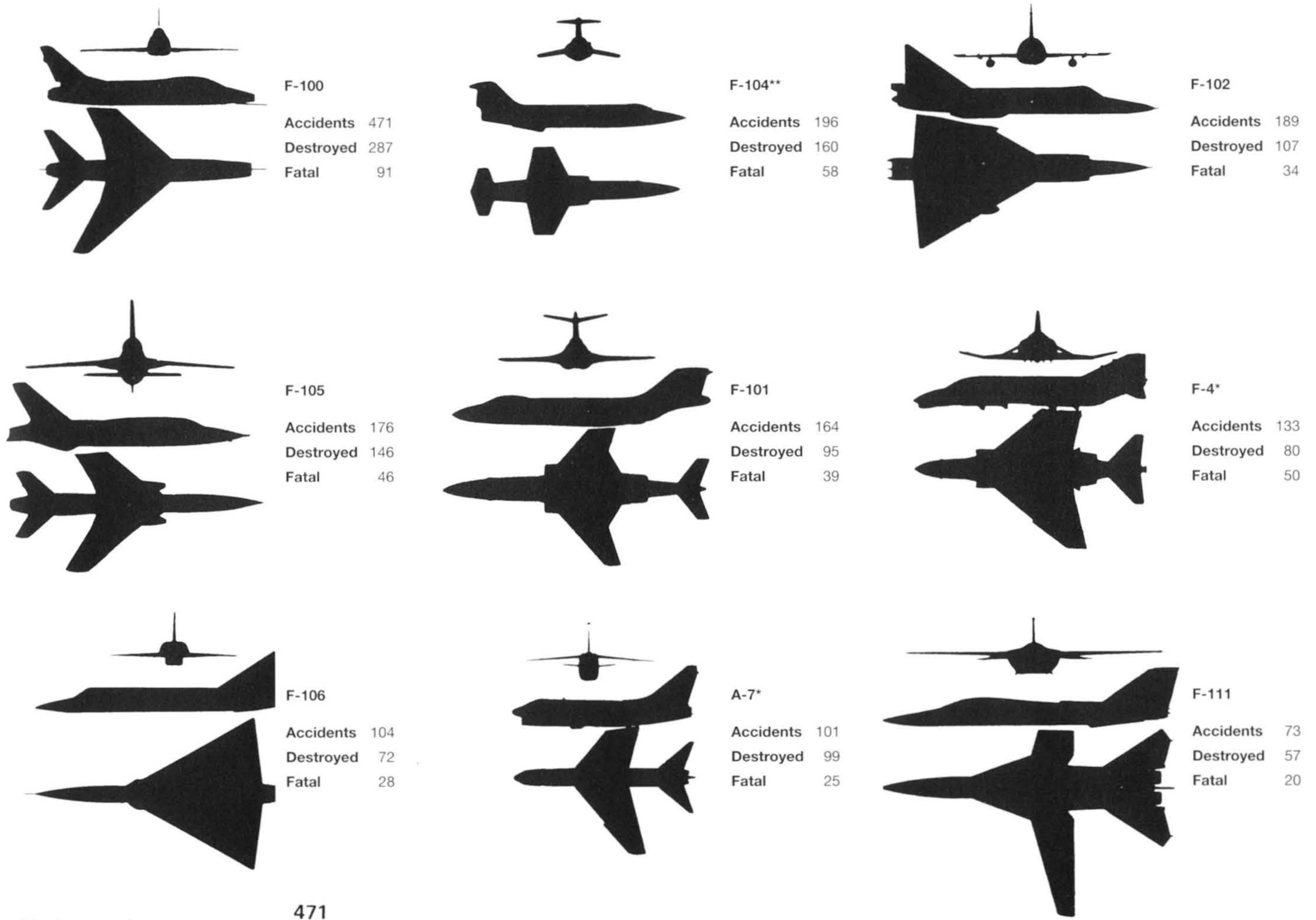
## Starfightergate

By the time of the 1966 German Federal election the Starfighter played a role in the fall of the Chancellor, Ludwig Erhard.[5] That summer Lt Gen Werner Panitzki, commander of the *Luftwaffe*, gave a newspaper interview in which he claimed that the selection of the Starfighter had been a political decision, and that the entire procurement programme had been flawed. Panitzki then offered his resignation, but he was suspended and sacked. His successor was the Second World War fighter ace (with 176 victories – six with the Me 262 jet) Lt Gen Johannes 'Macky' Steinhoff, an erstwhile critic of the quantity and speed of introduction of the F-104 into service.

Steinhoff immediately set to work restoring the shattered morale problem in the *Luftwaffe*. (As Kommodore of *Jagdverband 7* in the Second World War, the first-ever jet fighter *Geschwader*, he was charged with evolving tactics suitable for the new Me 262 jet and was arguably the *Experte* who had the greatest influence on its subsequent operations). By now the Starfighter was known as the *Fliegender Sarg* ('Flying Coffin'), or the *Witwenmacher* ('Widow-maker'). Sick jokes abounded. The *Luftwaffe*'s definition of an optimist was 'a Starfighter pilot who gave up smoking because he was afraid of dying of lung cancer'. Steinhoff grounded all the German Starfighters while the ejection seat system

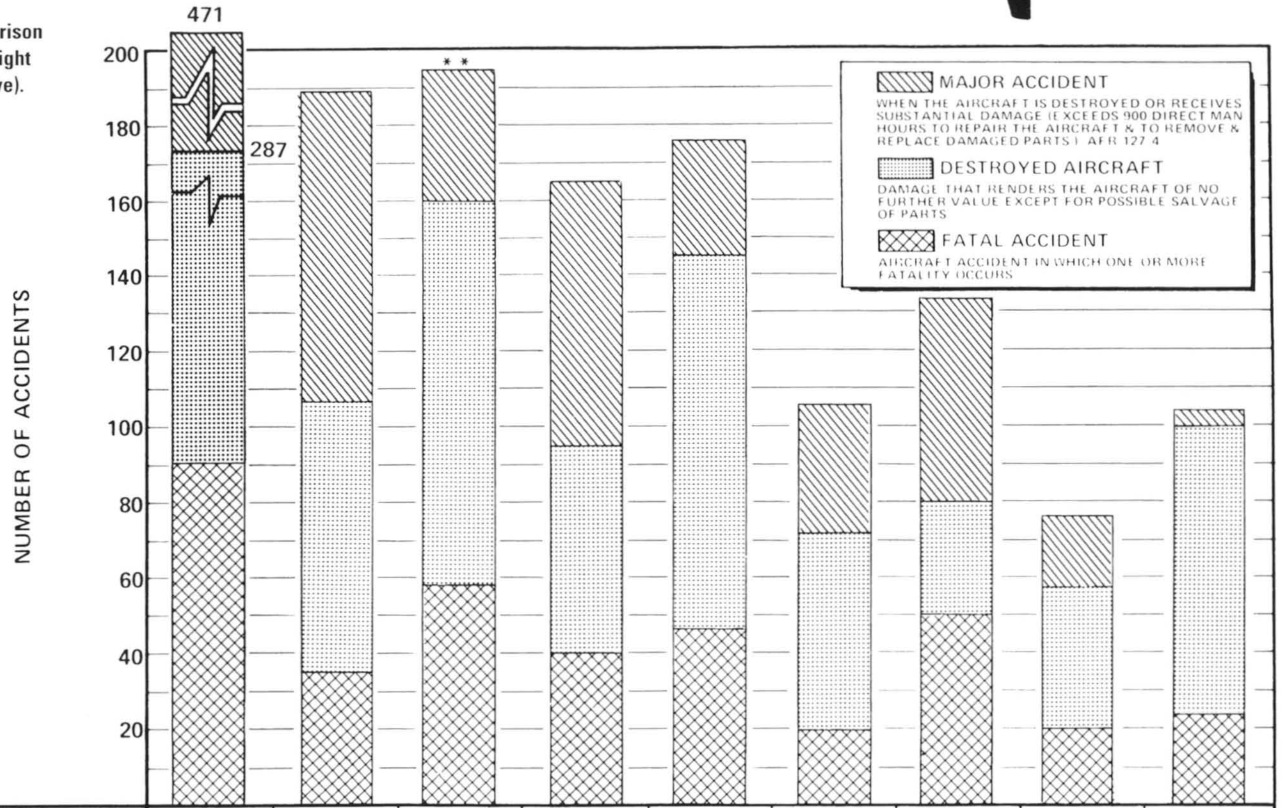

duplex drogue assembly
face screen firing handle
guillotine unit
headrest pad
parachute restraint pad
power retraction unit
parachute ejector spring support bracket
seat pan
sticker strap clip
emergency oxygen operating lever
seat pan firing handle
inward relief and excess pressure valve
personal equipment connector
safety guard
emergency oxygen manual operating control
go-forward control
taper plug locks
leg restraining cord manual release
leg restraining cords
rocket motor

**By the time Martin-Baker were approached to replace, firstly, the downward-ejecting seat in the** Kongelide Danske Flyvevübnet **(KDF, Royal Danish Air Force), followed by retrofitting the West German upward-ejecting Lockheed C2 versions, most Starfighter operators were becoming displeased with the performance of the Lockheed seat and started to consider replacing it. Sadly, the level of fatalities was becoming unacceptable to some Air Chiefs of Staff in NATO. Martin-Baker originally designed the Mk.GQ5 (90 knot) seat for the RDAF and West German aircraft in limited numbers, which gave some improved performance but it was soon replaced by the Mk.GQ7/7A for the** Aeronautica Militare Italian **and** Elliniki Aeroporia**, together with modifying the Mk.5 seats all having a zero zero (rocket-assisted seat) performance which restored confidence in NATO. To date, the success rate for the Mk.GQ7A (Mk.7 seat pictured) still in service in limited numbers is 92.3 per cent. (The Belgian, Norwegian, Dutch and Turkish Air Forces retained the Lockheed C2 seat throughout their service operations).** Martin Baker



| | Accidents | Destroyed | Fatal |
|---|---|---|---|
| F-100 | 471 | 287 | 91 |
| F-104** | 196 | 160 | 58 |
| F-102 | 189 | 107 | 34 |
| F-105 | 176 | 146 | 46 |
| F-101 | 164 | 95 | 39 |
| F-4* | 133 | 80 | 50 |
| F-106 | 104 | 72 | 28 |
| A-7* | 101 | 99 | 25 |
| F-111 | 73 | 57 | 20 |

**Accident comparison at first 750,000 flight hours (cumulative).**



| AIRCRAFT | F-100 | F-102 | F-104 | F-101 | F-105 | F-106 | F-4* | F-111 | A-7* |
|---|---|---|---|---|---|---|---|---|---|
| FIRST FLIGHT | MAY 1953 | OCT 1953 | FEB 1954 | SEP 1954 | OCT 1955 | DEC 1956 | MAY 1958 | DEC 1964 | SEP 1965 |
| DATE ACHIEVED | MAY 1959 | MAR 1962 | JUN 1977 | SEPT 1963 | MAR 1967 | JAN 1972 | MAR 1967 | DEC 1977 | FEB 1978 |

* Includes Navy data 1st 150,000 hours and Air Force data only beyond 150,000 hours
** 600,000 flight hours (has not achieved 750,000 flight hours)

was thoroughly checked and introduced a new training and retraining syllabus until losses, and in particular, fatalities, were reduced to a 'more acceptable' level.

In 1971 a report by the West German Government auditor general strongly criticized the original purchase of the F-104 Starfighter which had 'weakened materially and psychologically the defensive power of the air force, and entailed additional costs running into hundreds of millions of marks'.

He blamed Franz Josef Strauss, saying that when the order was placed he had given insufficient, and in some cases, false, information, about the Starfighter to the Budget and Defence committees of the *Bundestag* (West German parliament). Later, the auditor announced that he had found enough spare parts for the F-104G stockpiled in depots to keep the Starfighter supplied for 100 years and that most would never be used.[6]

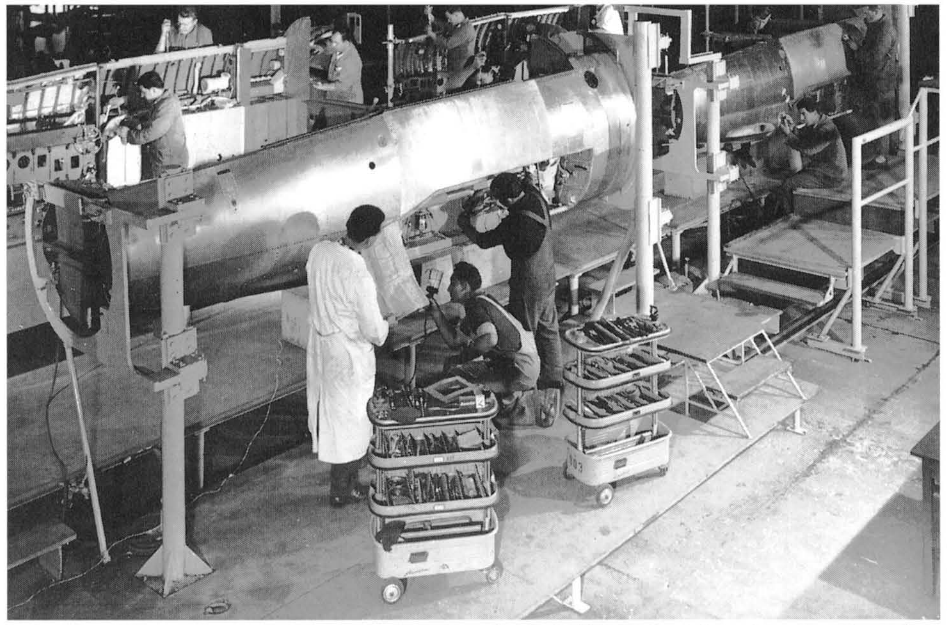
By the end of 1975 the *Luftwaffe* and *Marineflieger* combined had suffered no fewer than 174 crashes. By late 1982 the Luftwaffe had lost or written off 252 F-104s. All told, Germany lost or wrote off 315 Starfighters, 248 of them F-104Gs, 33 TF-104Gs, and 34 F-104Fs.[7] Altogether, the *Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu)*, (Belgian Air Force) lost or wrote off thirty-nine Starfighters, and the *Koninklijke Luchtmacht (KLu*, Royal Netherlands Air Force), forty-four.

Of the 200 CF-104s operated by the RCAF/Canadian Armed Forces, thirty-seven Canadian pilots lost their lives. By 1975 Japan had lost or written off fifty-four of its 230 Starfighters.

## End Game

The sale of the Starfighter took place against a background of stiff competition in the US aircraft industry where winning is everything. In 1965 Lockheed-Georgia had been awarded a contract to build 115 C-5 Galaxy jet transports, but in November 1969, this was reduced to eighty-one aircraft. Lockheed was already having to come to terms with problems with AH-56A Cheyenne helicopter production for the US Army, a project which was finally terminated in August 1972. It ultimately forced Lockheed out of the helicopter business forever.

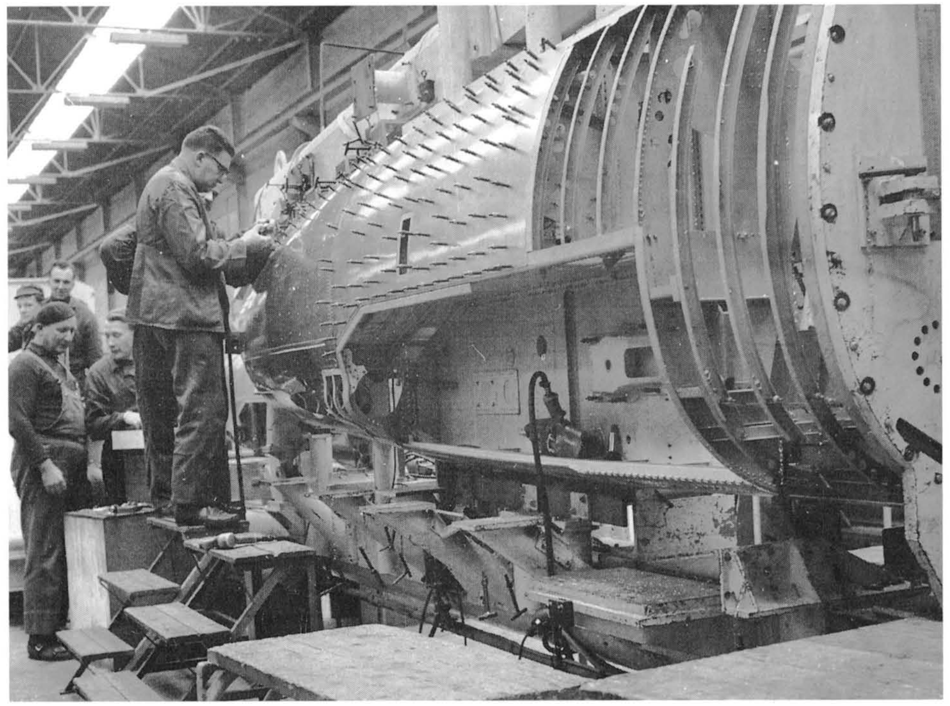
Lockheed were more successful, in 1969, in winning the VSX competition with the resulting S-3A Viking for the US Navy (the Viking would remain in production until 1978). The Lockheed Propulsion company, meanwhile, encountered insurmountable problems with a solid-fuel engine for the Boeing Short Range Attack Missile, and the company was finally inactivated. Another highly expensive enterprise was the proposed L-2000 supersonic transport, which lost out to the Boeing 2707.



***(Above)* Altogether, Starfighters were produced by manufacturers in seven countries and on 1 December 1960 Starfighter production commenced at German plants. These F-104Gs are being produced by Messerschmitt AG at Augsburg, the major corporate partner for Lockheed, which built 210 F-104G Starfighters. Messerschmitt was responsible for production flight testing and final assembly painting, construction of the pilot seat, the fuselage, empennage and the installation of the powerplant.** Messerschmitt AG

**Fiat-built F-104Gs under construction at Turin-Caselle. The Italian Group also included, Aerter, Macchi, SIAI-Marchetti, Piaggio and SACA. Altogether the group produced 329 F/RF-104G and F-104S models (124 F-104Gs and 205 F-104S aircraft for the AMI; 15 F-104Gs and 35 RF-104Gs for Germany; 25 F-104Gs for the** KLu**; and 40 F-104S aircraft for Turkey).** Fiat

At first there seemed no future for the three-engined (Rolls-Royce RB.211) L-1011 TriStar airliner, which lost out to the McDonnell Douglas DC-10. However, Lockheed landed orders for 172 TriStars from four major US airlines. In 1971 Rolls-Royce Aero Engines were placed in the hands of the receivers and production of

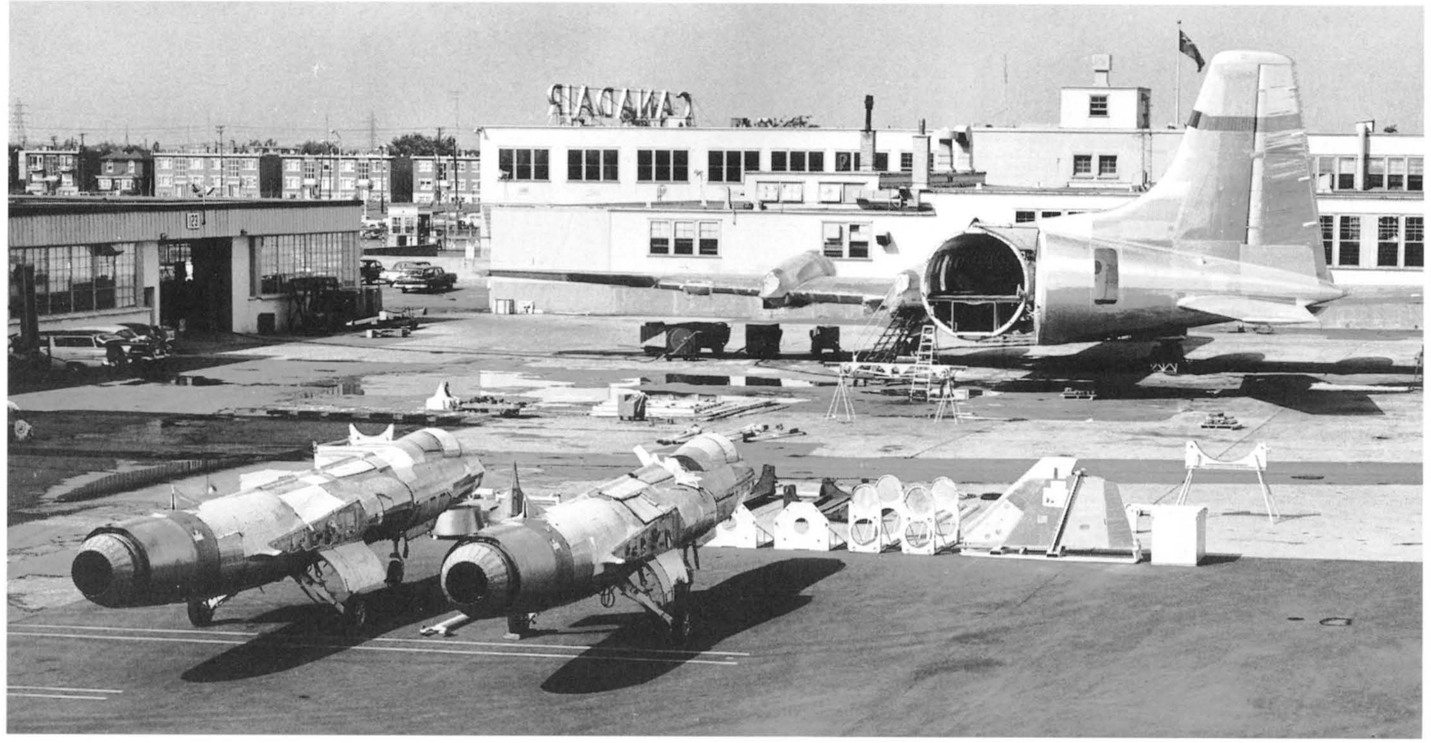


**F-104G aircraft being produced at Avions Fairey SA, Belgium, which, with SABCA** (Société Anonyme de Constructions Aéronautiques)**, was part of the West Group. They built 187 F-104Gs (100 for the** Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu)**, and 87 for the** Luftwaffe/Marineflieger**) using fuselage nose radomes, air scoops, ducts and aft fuselage sections built by Siebel, and dive brakes, main landing gear doors, horizontal stabilizers, fins and rudders, manufactured by Heinkel, and nose landing gears made by Dornier.** Avions Fairey SA

***(Below)* Roll-out, on 27 March 1961, of the first of 200 CF-104 Starfighters for the Royal Canadian Air Force at Canadair Ltd, Montreal.** Canadair

TriStars ceased immediately. Without Government help, Lockheed Aircraft Corporation would have followed the British engine manufacturer into bankruptcy. Funds were forthcoming, but Lockheed faced many more financial and political setbacks until it entered profitability again in 1973.

Two years later, the Lockheed Bribes scandal broke when the publication of a Lockheed company report revealed that $22 million in 'sales commissions' had been paid to foreign officials, including at least $1 million to Prince Bernhard of the Netherlands. At the end of 1975 Lockheed Corporation's insurance companies finally agreed to distribute $1.2 million among thirty-one widows of German Starfighter pilots. In the summer of 1976 it was discovered that the entire set of files covering the German purchase of the F-104G had gone missing from defence ministry headquarters in Bonn.[8]



**F-104G (MAP) fuselages waiting to be flown out from Canadair's Montreal plant for shipment to Europe. The first Canadair CF-104 was airlifted to Palmdale, California, where it was first flight tested by Lockheed on 26 May 1961. Altogether, Canadair built 140 F-104Gs as part of the Military Assistance Program.** Canadair

**Landing on the runway at an airbase in Italy is the Lockheed-designed, Fiat-manufactured F-104S. A total of 165 of the advanced model Starfighters was built. Some were later brought up to F-104ASA standard.** Lockheed

The bribes scandal rocked Lockheed Aircraft Corporation to its very foundations, and the chairman of the Board and the vice-chairman and president were forced to resign. On 1 September 1977 the Lockheed Aircraft Corporation became simply, Lockheed Corporation.

The very last Starfighter, the 245th and final Italy-produced F-104S, was rolled out in March 1979. World-wide Starfighter production had therefore reached 2,577, 1,241 of them having been produced in Europe.

In his book *The Arms Bazaar*, Anthony Sampson sums up the role played by the Starfighter when he says:

> As for the effectiveness of the Starfighter in the defence of Europe, no one will ever know. It was never proved in battle, whether in Europe, Vietnam or the Middle East. By the mid-seventies it was already being replaced, and its place in history rests less on its performance than its scandals.

CHAPTER ONE

# A New Star is Born

Six small silver jet fighters bearing red stars on their stubby fuselages and swept-back wings took off from the safety of their air base at Antung in Manchuria, climbed rapidly to 30,000ft (9,140m) and crossed the Yalu River into North Korea. It was the afternoon of 1 November 1950. A few months earlier, on 25 June 1950, the North Korean Army had crossed the 38th Parallel and invaded South Korea. The invasion had caught the ROK (Republic of Korea) Army and its American advisors completely off balance and from the outset the North Koreans enjoyed total air superiority. By late 1950 the North Koreans had the Allies penned in around Pusan and in August the Communists attempted to cut the Pusan Perimeter in half.

The mainstay of the US 5th AF in the Pacific was the Lockheed F-80C Shooting Star jet interceptor, of which three wings were based on Japan, supported by two wings of North American F-82 Twin Mustangs. In addition, the 20th AF had one F-80C wing and an F-82 wing based on Okinawa, Japan, main base for the command's B-29 operations over Korea. These new types of USAF aircraft were ill-suited to operate in a close air support and interdiction campaign in Korea. They needed paved runways 6,000ft (1,800m) long and these only existed in Japan which meant that air operations over Korea were restricted to only a few minutes.

Since the start of the war in Korea, US commanders had no reason to fear the Communist air threat because only piston-engined aircraft had confronted the USAF F-51s and F-80s, and the US Navy's fighter bombers. Gen Emmett O'Donnell's B-29s had made repeated raids on industrial targets in the North with impunity. United Nations forces had broken out of the Pusan Perimeter on 19 September 1950 and within a week and virtually annihilated the North Korean army. Fifth AF had accounted for 8,000 enemy troops in just five days in the face of disintegrating North Korean air activity. Fighter-bomber wings based in Japan were sent to reoccupy hastily repaired airfields in South Korea and to be ready for the imminent invasion of the North. All went well until the United Nations' advance reached the banks of the Yalu River.

The overwhelming balance of air power in North Korean airspace now changed dramatically with the intervention by Communist China and the appearance of the Soviet-built jets on that fateful day, 1 November 1950. The formation of piston-powered, propeller-driven F-51 Mustangs, and straight-winged F-80 Shooting Stars, flying on the North Korean side of the river were surprised at the devastating closing speed of the Communist jets, whose pilots failed to destroy the American aircraft only through their own inexperience.

The MiG-15 was the result of a Soviet project in 1946 which benefited from German research into swept wings and the Rolls-Royce Nene turbojet, of which twenty-five were sold to the Soviets under the Anglo-Soviet Trade Agreement of 1946. The Nene engine provided more thrust than the earlier Soviet-built powerplant based on the German Jumo 004 and was installed in the prototype which flew for the first time in 1947. Early production MiG-15s were powered by an RD-45F centrifugal-flow turbojet copied from the Rolls-Royce Nene. The MiG-15 could fly at near sonic speed and was armed with one 37mm and two 20mm cannons.

The North American F-86 Sabre, like the MiG-15, had benefited from German research into wing design. The first Sabre design was a straight-wing version and had flown for the first time in November 1946 but the results of German wartime research into swept wings led to a 35 degree sweep angle being adopted by its North American designers. The XP-86 made its maiden flight on 1 October 1947 and the following spring it exceeded Mach 1, in a shallow dive, for the first time. In September 1949 an F-86A set a world speed record of 671mph (1,080km/h). In Korea the Sabre was found to be the equal of the MiG-15 but the lighter enemy jet proved to have the edge over the F-86A in climb and altitude performance and was more manoeuvrable.

The Korean War shook the military might of America and it led to far-reaching changes in the equipment that it would need to fight any similar war anywhere in the world. Propeller-driven combat aircraft could no longer survive in the front line of any new conflict that flared up in the 1960s and in the aftermath of the Korean War, American and Soviet designers sat down with their design teams to think up powerful new replacements for the USAF, US Navy and US Marine Corps.

## Missile with the Man in It

Although the XF-90 Penetration Fighter had lost out to the McDonnell XF-88A Voodoo on 11 September 1950, the experimental Lockheed fighter had proved to be a valuable learning tool for the Advanced Development Projects at Palmdale. Following a Request for Proposal issued by the US Air Force in September 1950, Lockheed progressed onto an all-weather fighter interceptor studied under the Temporary Design Designation L-205. Powered by a 15,000lb (6,800kg) thrust afterburning General Electric XJ53-GE-X10 turbojet, the L-205 won the design competition and two prototypes were ordered. Armament was to consist of six MX-904 air-to-air guided missiles carried in a fuselage bay beneath and aft of the dorsal intake, and twenty 2.75in FFAR rockets on the sides of the armament bay. The L-205, now known as the Basic Model Number 99, was almost built in prototype form when concern over anticipated weight increases and resultant downgrading of performance led to the US Air Force cancelling the development contract in January 1951.

In May 1952 Lockheed was offered a new contract for the construction of prototypes of a Wright J67-powered, 16-ton interceptor, but the company declined to bid for the fighter when the USAF insisted on a clause forfeiting all patent features and allowing the US government to assign production of the new fighter to other manufacturers. Another reason for Lockheed's reluctance to bid was because its Advanced Design Group was already working in secret on a much simpler, and considerably lighter proposal, designated the CL-246. After all, the Soviets had shown the way to the stars and in Britain W.E.W. Petter at Folland, and in the USA, Ed Heinemann at Douglas, had followed. Petter evolved the Midge and Gnat lightweight fighter designs while Heinemann's lightweight fighter, which unfortunately failed to interest the US Navy, would successfully be developed as the A-4 light attack aircraft. In France too, several new Intercepteur Lèger (light interceptor) projects such as the SFECMAS 1402 Gerfaut, SE.212 Durandal, SO.9000 Trident, and Marcel Dassault's MD.550 (forerunner of the Mirage) were under development.

At Lockheed, Hall Hibbard, chief engineer, and Clarence L. 'Kelly' Johnson, assistant chief engineer and chief designer, were determined to make the Skunk Works facility number one when it came to jet-fighter design. And it would be a lean lightweight rather than a heavyweight, at least initially. Johnson had gone to South Korea in 1951 to see how his F-80 performed.

**Clarence 'Kelly' Johnson, and the Model 83 Starfighter. Combat with Soviet-built MiG-15s during the Korean War 1950–53 indicated that the US needed a new jet fighter to succeed the F-80 and the F-86 Sabre. Among the designs considered was the Starfighter created in November 1952 by Clarence 'Kelly' Johnson's famed 'Skunk Works' design group at the Lockheed California Company in Burbank.** Lockheed

While there he visited fifteen air bases in a search for information from the USAF pilots themselves as to their requirements for an ideal fighter aircraft. USAF fighter pilots were unanimous in their wish list. They wanted a pure daylight air-superiority fighter that not only could surpass the Communist jets, but totally outclass them, both now, and in the foreseeable future. What they did not want was an ejection seat, parking brakes, duplicated flying control systems, armour and radar equipment. Col Francis X. 'Gabby' Gabreski, the top scoring Second World War fighter ace, and an ace in Korea, even went as far as to tell Johnson that radar was a waste of time: 'I'd rather sight with a piece of chewing gum stuck on the windscreen', he said. (As it turned out, Gabreski's ideas on radar would certainly hit the mark as far as the Starfighter was concerned). Using their hard-won experience against the MiG-15s, American fighter pilots knew that any new fighter had to be a lightweight, uncomplicated design so that greater speed could be achieved, and it must be capable of greater performance and able to reach higher altitudes than the Communist-built MiG series.

The dedicated team of Advanced Development Projects engineers were of the same opinion. At this time the key personnel involved on the air superiority fighter programme included men with several years of jet design experience behind them. Johnson's Project Engineer was William P. 'Bill' Ralston. He had assisted Kelly Johnson on the XP-80 Shooting Star project and was one of the two Project Engineers on the XF-90 Penetration Fighter programme. As chief of engineering for Lockheed's experimental department, Arthur M. 'Art' Vierick supervised the shop group. Vierick, like Kelly Johnson, and Dick Boehme, another key engineer on the air superiority fighter programme, were in the first group of twenty-eight original Skunk Works engineers who had worked on the XP-80 Shooting Star. Philip A. 'Phil' Colman was a key aerodynamicist on the Temporary Design Number L-133 project. Rus Daniell was an aerodynamicist who had been entrusted by Kelly Johnson to develop the YF-94 Starfire (Model 780) project.

Eugene C. 'Gene' Frost had, with Kelly Johnson, Phil Colman, and Willis M. Hawkins (another member involved on the air superiority fighter programme), designed the L-133 airframe.

R. Richard 'Dick' Heppe had joined Lockheed in 1947 and had been involved in the design of the XF-90. (In 1974 he became a vice-president of Lockheed Corporation, and ten years later he became vice-president and general manager of the Skunk Works.)

Benjamin R. 'Ben' Rich, who had joined Lockheed in 1950 as an aeronautical engineer after abandoning plans to become a medical doctor, moved to the Skunk Works in 1954 and instead worked on cures for thermodynamics and propulsion problems in the design of advanced aircraft. Later, he would work on the preliminary design aspects of the A-12, YF-12, and SR-71 aircraft and the D-21 Drone. It was his suggestion that led to the A-12, YF-12 and SR-71 aircraft being painted black to reduce the extremely high temperatures on these airframes at triplesonic speed. In 1975 Rich succeeded Kelly Johnson as a company vice-president and general manager of the Skunk Works, a position he retained until 1990. Rich (and Phil Colman and Gene Frost), were later involved in Kelly Johnson's Secret Project Aquatone design, better known as the U-2. The remaining members of the key personnel involved on the air superiority fighter programme were John Stroud, Ed Baldwin, Henry Combs and James 'Jim' Hong.

### *The X-3 and the Thin Wing Approach*

After returning from Korea, in November 1952 Johnson began to design a dedicated air superiority fighter, even though at this time, the USAF had no requirement for such an aircraft. Johnson and his team could draw upon classified supersonic flight data produced both by the US Air Force and the US Navy. During the development of the F-104, Lockheed drew heavily upon information gleaned during NACA wind tunnel tests of the proposed Douglas X-3 Stiletto project, built to investigate the design features of an aircraft suitable for sustained supersonic speeds, and which flew on 20 October 1952.

Because of adverse drag divergence and pressure shifts at transonic speeds, the Douglas team designed the low aspect ratio wing for the X-3 with a thickness chord ratio of only 4.5 per cent. (The F-104 wing would embody much the same characteristics as the X-3 wing. It would have a sharp lading edge with a thickness ratio of just 3.36 per cent, and a maximum thickness of only 4.2in adjacent to the fuselage and only 1.96in at the tips.)

Building a wing as thin as this involved considerable design problems. Deflection of ailerons at high speed could cause a thin wing to twist with aeroelastic effects, perhaps causing structural failure, unless the wing had a sufficiently strong and rigid structure. Accordingly, the design team decided to build the wing around an aluminium alloy core having its longitudinal and transverse members machined from a single slab. Stretch-levelled aluminium alloy plate ½in (1.27cm) thick at the wing root and ¼in (0.635cm) thick at the tip would cover the core.

A RAND Corporation study of F-104 development concluded with the following comment:

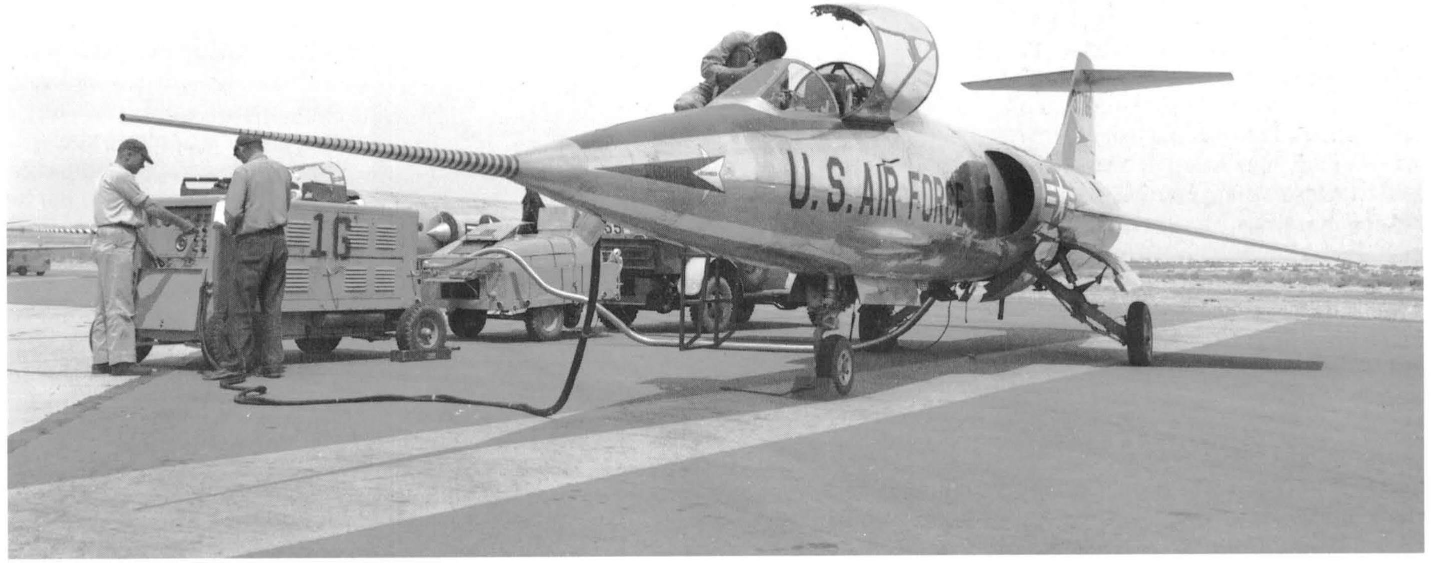
> The F-104 history illustrates that research and development in one program can have a great carry-over value to another. [Apart from the low-aspect stubby wings, other features used on the X-3, such as smoothly-faired engine intakes mounted on the sides of the fuselage, an all-moving horizontal stabilizer, and a downward-firing ejection seat, were evidenced later in the Starfighter design]. Lockheed's success in building and flying a prototype less than a year after go-ahead would very probably not have been possible without the knowledge derived from the Douglas X-3 program. Although the value of this experimental effort in the F-104 effort would hardly have been anticipated when the Air Force money was advanced to finance the program, nevertheless the value to the Air Force of the X-3 program extended far beyond the immediate results achieved with it.

Regrettably, the X-3 never had the opportunity to approach its maximum design performance. The failure of the proposed Westinghouse J46 engine was judged by one RAND Corporation study as 'a classic case of engine-airframe commitments being made in the face of great uncertainty about all engine magnitudes'. As predicted, J46 development (which promised a maximum thrust of 4,200lb (1,907kg) static thrust without afterburning and 6,600lb (2,296kg) with afterburning), proved long and complicated. In the event, the X-3 was powered by the lower rated J34-WE-17. (The X-3 was powered by two J34s, each capable of developing 3,370lb static thrust (1,530kg) and 4,850lb st (2,202kg) with afterburner). If the Starfighter was to succeed, then the same hurdles of wing design and engine performance had to be overcome by Johnson and his team.

### *No Visible Means of Support?*

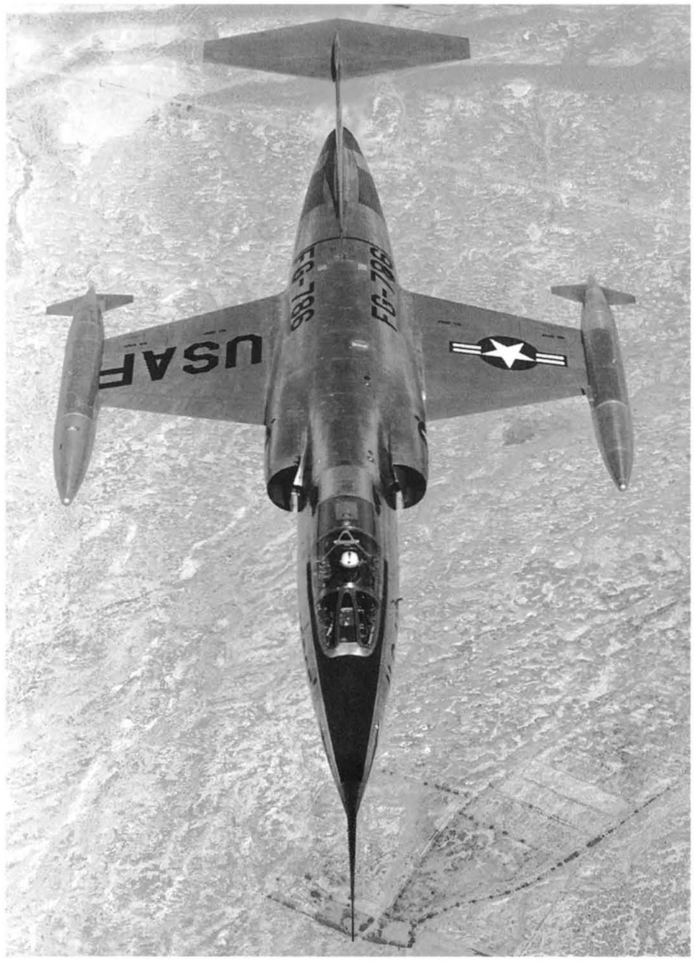
At least fourteen completely different designs were considered in 1952 before Lockheed decided finally on the F-104 configuration. The designs that were studied, tested and abandoned included, sliding intake centrebody, flush cockpit, rocket propulsion, wingtip-mounted tail booms, nacelle-retracting landing gear, V-shaped windshield, low mounted stabilizer, and delta and swept-wing.

Swept-back airfoils require thick chord and long span (with attendant high drag) to give performance comparable to the short, straight wing. Extreme sweep also affects handling characteristics. Every square foot of delta wing has less drag in a certain mach number region (somewhere between 1 and 2) than a corresponding square foot of straight-thin wing. Every square foot of straight wing, however, lifts roughly twice that of a delta. By the time there is enough delta wing area for a given load, total drag is considerably higher than a straight wing presents. The delta has lower transonic drag than straight wing (the reason why many subsonic aircraft use this configuration). So in the transonic regime, from Mach 0.85 to 1.3, a delta will accelerate faster through Mach 1, but



**XF-104-LO prototype 53-7786 (Company 1001), which was used as the aerodynamic testbed, being preflighted at Edwards AFB adjacent to Runway 22 (the first YF-104A service test model is just visible behind the power carts). Years ahead of its time, the new aircraft had an extremely small, thin wing area and long, tapered nose (it also had a downward-ejecting seat). This and the second prototype (53-7787) were powered by a Wright 11,500lb (5,216kg) thrust XJ65-W-6 (Sapphire) with afterburner giving a maximum speed of Mach 1.79. On 27 April 1955 Maj Howard C. Johnson powered the XF-104A to Mach 2 for the first time.** Lockheed above Mach 1.4, the F-104, with its trapeze wing planform, would out-accelerate delta-winged aircraft such as the F-102 and F-106. While many aircraft can attain Mach 2 in 'dash-speed', the F-104 was designed to *cruise* at Mach 2.

Johnson and his design team studied Lockheed's own programme of flight trials up to Mach 4 at over 150,000ft (45,700m) using unmanned rockets. This programme clearly showed that at speeds in excess of Mach 2 a short, stubby, unswept, very thin wing, was the most suitable. As has already been pointed out, so far, only difficulties in building such a thin wing without a consequent loss of strength in the structure had prevented its manufacture. Being short and thin, the F-104 wing (which would extend only 7½ft (2.29m) from the fuselage) encountered little drag. A sharp leading edge (which would have a thickness ratio of 3.36 per cent, a maximum thickness of 4.2in (10.67cm) adjacent to the fuselage and only 1.96in (4.98cm) at the tips) sliced through the air and eliminated such mach effects as buffeting and tucking. (The wingtip chord was approximately 38 per cent of theoretical root chord and leading edge sweepback was approximately 26 degrees. The leading edge was so thin and sharp it was said that it was sharp enough to cut meat with. The trailing edge had a smaller sweep forward and was fitted with hydraulically operated ailerons and flaps.)



**Overhead plan view of XF-104-LO prototype 53-7786 showing the trapezoidal wing planform and high T-tail configuration with all-moveable stabilators (stabilizers and elevators) which moved as one unit, to good advantage. With the two 170gal wingtip tanks mounted, the maximum speed allowed was limited to Mach 1.8. The fuel weight and distribution in the tanks was critical, as an incorrectly loaded tip tank (with only the rearmost of its two compartments filled) could create aerodynamic flutter building to a point where it would literally tear the wings off the aircraft. 53-7786 was lost in a crash on 11 July 1957.** Lockheed

Lt Col David L. Bashow, a very experienced CF-104 Starfighter pilot in the Canadian Air Force, has said:

> Rumour has it that Johnson gave birth to the F-104 on a restaurant napkin. Apocryphal or not, it must have been a small napkin because he obviously didn't have room for the wings. What emerged was a timeless design that looked like it was going Mach 2, just sitting on the ramp. Although the radical wing design produced very little drag at high speeds, its smallness resulted in high aerodynamic wing-loading (around 95lb/ft). Unfortunately, this doomed the aircraft to relatively poor manoeuvrability, since wing-loading is such an essential ingredient in turning performance. In all fairness to Johnson and the design team, however, the 104's initial role was envisaged as a high-speed point defence interceptor against the relatively poor manoeuvring manned bomber threat.

Johnson's Model 83 design, considered to be years ahead of its time, was so radical, so revolutionary, that even the American fighter pilots would surely have been surprised by the Skunk Works' ingenuity. Apart from the extremely small, very thin straight wings that were angled downward 10 degrees, and a long, tapered nose, the new aircraft was also characterized by a unique high T-tail configuration with all-moveable stabilators (stabilizers and elevators) which moved as one unit. Kelly Johnson, Phil Coleman, Dick Heppe, and James Hong designed the F-104's unique empennage.

### *T-Tail*

Wind tunnel tests proved that a high tail position was necessary for optimum stability and control about the pitch axis throughout the F-104's wide Mach range. The location of the horizontal stabilizer on top of the vertical tail raised the centre of pressure on the tail thereby increasing induced roll effect during sideslip. To compensate for the increased roll that resulted from the vertical tail, negative dihedral (or anhedral) was put in the wing (anhedral angle is approximately 10 degrees). The stabilizer, which was only 3⅗in (9.1cm) thick at the inboard edge and slimming to a mere ⅗in (1.5cm) at the tip, was located only 11in (28cm) from the top of the swept-back vertical fin. (It was later constructed with a single spar covered with skin panels and the hinge movement was along the spar line. Hinge and operating controls were both enclosed by the empennage contour. This avoided using external fairings that were normally used to cover such items. Built on two steel fuselage forgings supporting two fin forged spars, the fin contained boost servo units for empennage control surfaces.)

The F-104's high T-tail layout was also designed to counter pitch-up, a problem common to all aircraft but more so for small, high-speed aircraft. As it turned out, the configuration did not counter pitch-up enough, and the tail had to be repeatedly modified later. Ultimately, the only solution to the problem was to install complex electronic systems to provide automatic pitch control.

Almost all the F-104's equipment was contained within the fuselage (in the electronics' compartment or 'E Bay' located beneath the aft section of the cockpit canopy, about 5ft along the aircraft axis), including the fuel tanks (five bladder-type fuel cells) and the retractable undercarriage. The semi-monocoque airframe was of steel, aluminium and titanium and the turbojet and the afterburner exhaust ejector nozzle were housed in the streamlined fuselage. To save weight, Johnson had dispensed with heavy pressurization equipment, but this meant that the pilot would most likely have to wear a bulky and highly uncomfortable spacesuit to protect him from the rapid decompression following flame-out at high altitudes. Stainless steel and titanium skins covered the aft fuselage section that housed the engine and carried tail loads into the mid-fuselage.

Kelly Johnson was firm in his resolve for the radical design of the Starfighter, as he was to recall.

> The large airplane exponents claimed that equal speed, range and fighting power could not be obtained in a smaller airplane because such fixed items as the pilot size, canopy size, engine thrust per square foot of frontal area, and fixed equipment item weights, were a smaller percentage of the large airplane weight than of the smaller one. Likewise, the fuselage cross-section and size, in general, would be unfavourable for the smaller airplane, resulting in lower ratios of lift to drag and thrust to drag, even if the same percentage fuel weight could be carried. There was not in existence a small engine which had as good thrust-weight ratios or specific fuel consumption as the larger engines then available. These factors were all true at the time; so it was necessary to make some rather major advances on practically all of these fronts before a successful light-weight fighter could be developed.[9]

Johnson's design team had fashioned an extremely lean and lightweight fighter aircraft with a high thrust-to-weight ratio to give it an advantage in the supersonic speed regime in which it would fly and fight. At an all-up weight of just 11,500lb (5,216kg) the XF-104 was half the weight of the competitors' proposed Weapon System 303A aircraft: the Northrop Model N-102 Fang, North American Model NA-212 F-100B(I) Ultra Sabre, and the Republic Model AP-55 Thunderwarrior.

Johnson showed his radical design proposal to Col Bruce Holloway at the Pentagon, who was immediately enthusiastic. He even went as far as to say that, 'Well if there isn't a requirement, I'm going to make one. Stick around Kelly. Come back in a couple of hours!' The colonel produced a list of requirements under Weapon System 303A, calling for a pure air-superiority day fighter with exceptional climb rate, speed, ceiling, agility and manoeuvrability; in other words – a pedigree dogfighter. If successful, the new and advanced lightweight fighter would supplement, and later replace, the North American F-100 Super Sabre. After obtaining authorization from Gen Donald L. 'Don' Putt (commander US Air Force Systems Command 30 June 1953–14 April 1954), and Gen Don Yates, a month later Holloway gave Johnson a General Operational Requirement calling for a lightweight air-superiority fighter. The colonel handed over the list of requirements and said, 'Kelly, go see what you can do with this.'

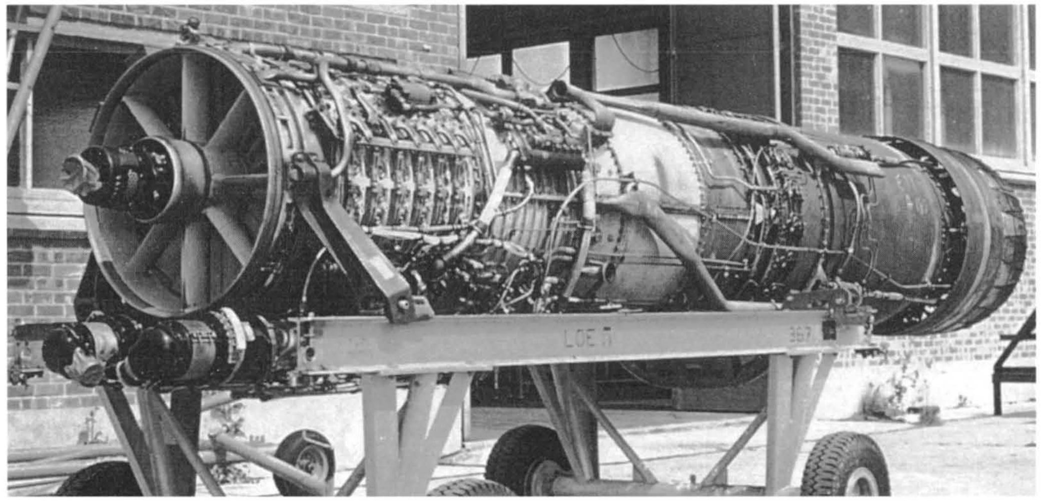
**XF-104-LO prototype 53-7786 in flight. On 28 February 1954 XF-104 53-7786 made an unscheduled short and straight hop before Lockheed test pilot Tony LeVier flew the number one aircraft for the first time on 4 March. On 25 March 1955 XF-104-2 53-7787, now powered by an afterburning Wright J65-W-7, and flown by Lockheed test pilot Ray Goudey, reached a top speed of Mach 1.79 (1,324mph/2,130km/h).** Lockheed

## Propulsion Systems

One of the biggest problems confronting the Skunk Works propulsion engineers was in deciding which turbojet would be the most suitable to power the XF-104. Foremost in the frame were the Allison J71, which was projected to produce up to 14,000lb (6,350kg) thrust with afterburning, the Pratt & Whitney J75, which was projected to produce up to 21,000lb (9,526kg) thrust with afterburning, and the General Electric J79, which was projected to produce up to 15,000lb (6,800kg) thrust with afterburning.

In 1941 General Electric had produced the first American-built turbojet powerplant, designated the I-A. It weighed 780lb and had a thrust – or pushing power – measured at 1,300lb (590kg). Pursuing its pioneering advantage, General Electric during the Second World War developed a new style engine built around an axial flow compressor. Earlier models, such as the J33 which powered Lockheed's F-80 Shooting Star, used a centrifugal compressor that propelled air outward from the centre of rotation. Axial flow means that the air flows straight through, 'packed' ever tighter by a series of spinning fan-like blades before fuel is added and ignited (the annular-design combustion chamber had a split casing that could be disassembled quickly and contained ten combustion chambers). The one big goal of engine manufacturers was an engine combining light weight with high thrust, mechanical simplicity and reasonable fuel economy.

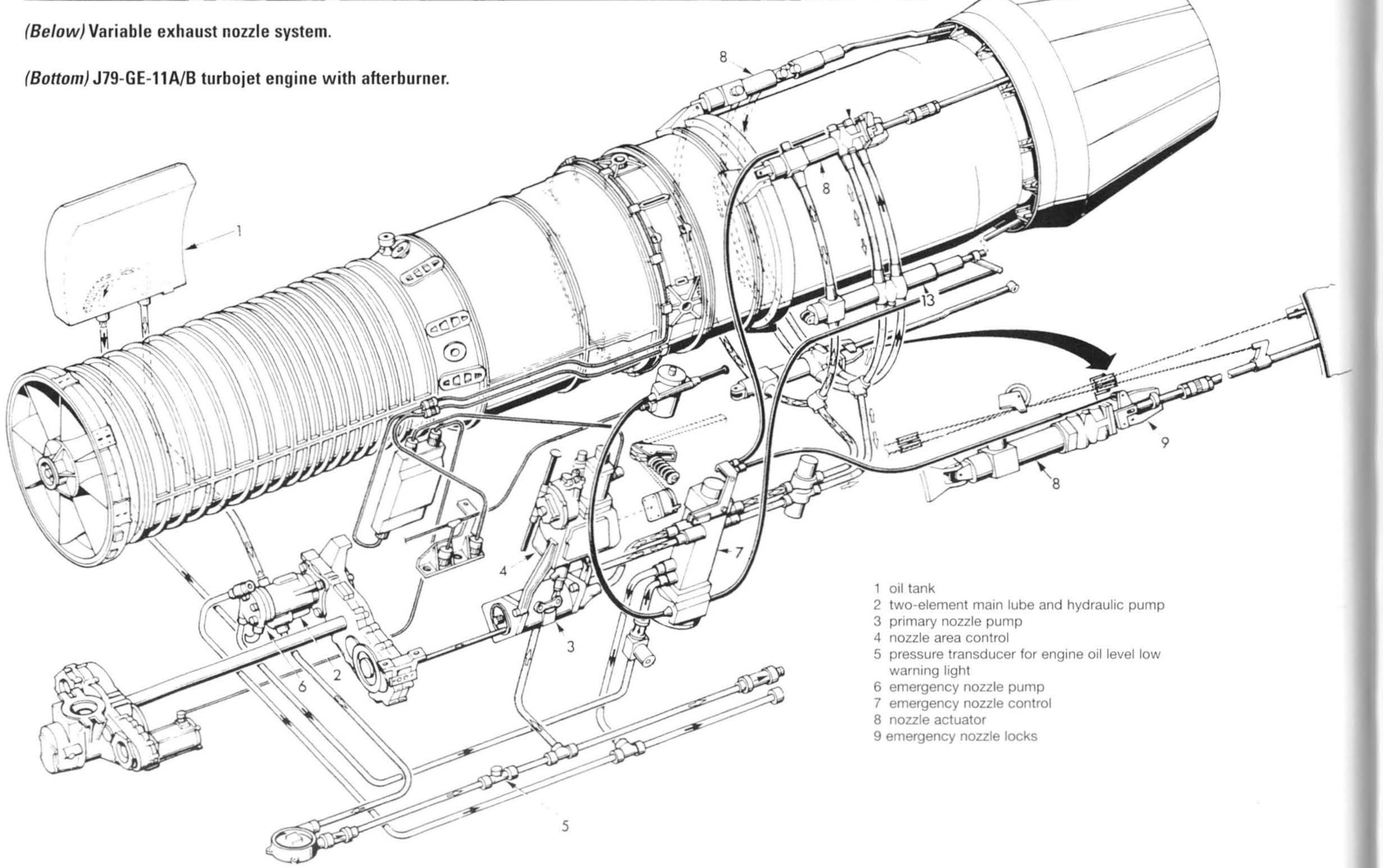
The J79 offered better specific fuel consumption and lighter dry weight than either the Allison J71 or Pratt & Whitney J75 competing engines. The J79 engine's thrust-to-weight ratio – 3,500lb (1,588kg) weight and 15,000lb (6,800kg) plus thrust – was unprecedented (pressure ratio was 12:1). Developed in cooperation with the USAF under the government's weapon system management concept, the J79 was

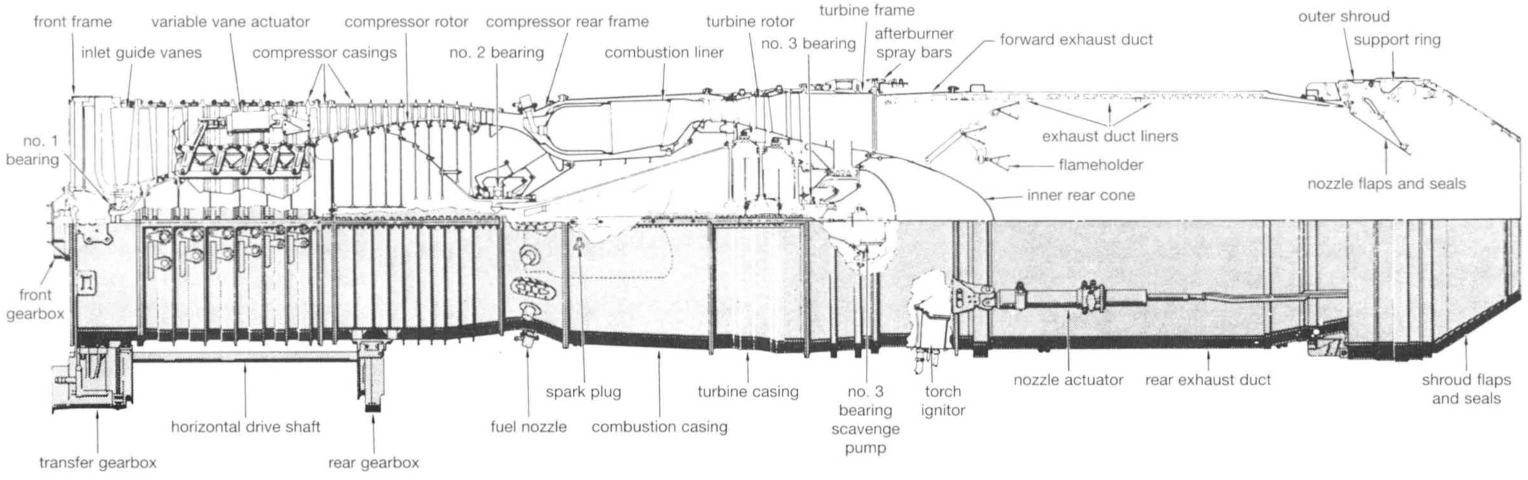


*(Left)* **J79-GE-11A/B turbojet engine with afterburner.**

*(Below)* **Variable exhaust nozzle system.**

*(Bottom)* **J79-GE-11A/B turbojet engine with afterburner.**





the first US production engine capable of powering aircraft at twice the speed of sound. However, the race to achieve this was no quick dash, rather an extended endurance test. The prize would only be forthcoming after the difficulties and setbacks which one associates with any such complex new powerplant were overcome.

Design had to permit rapid acceleration from idle to full power without compressor stall. Variable-pitch stator blades therefore had to adjust automatically to reduce stall problems at low engine speeds and give maximum compressor efficiency under all flight conditions to match engine and airframe induction system for good stall margin at high aircraft speeds. The axial flow compressor had seventeen stages and a single rotor, with the first six stator stages and inlet guide vanes variable. (The rotors were made of thin webbed discs and spacer rings bolted together. Blades were attached to the rim sections by conventional dovetails.)

The engine's separate fuel systems – main and afterburner – were flow-controlling units, hydro-mechanically operated. An integral part of the basic engine, controls had electrical trim, with both hydraulic and electric power. Overall, the system served main fuel, afterburner fuel, nozzle area and variable stator controls (integrated with main fuel controls). Afterburner features included fully modulated, variable area, with a converging–diverging exhaust nozzle that worked automatically.

Hydraulic power was assured by two independent systems working from engine-driven variable displacement pumps which could operate in varying temperatures. An emergency ram air turbine lowered from the right-hand side of the fuselage was to provide hydraulic power in the event of engine seizure that left the primary system intact. (A flamed-out but rotating engine would give adequate hydraulic flow and pressure for surface control.) The ram air turbine permitted safe flight and moderate manoeuvres and supplied emergency electrical power.

Not unsurprisingly perfecting the J79 engine was anything but straightforward. Of course engine development problems were not restricted to General Electric alone – equally they had to be faced by the leading jet engine manufacturers in the USA and in Europe. Although the J75 turbojet (designated X24A under secret project MX-2118) was expected to be available sooner. However, the J79 was not scheduled to be available until early 1956 (it would need more than 12,000h of factory, simulated altitude and flight testing time) and this would not be soon enough, because contractor Phase I flight-test requirements were due to start early in 1954. Therefore, the powerplant used initially to power the first XF-104, originated in Great Britain.

Lockheed finally selected the non-afterburning Wright Aeronautical XJ65-W-6, an Americanized version of the Armstrong-Siddeley Sapphire axial-flow turbojet.[10] This engine, which was built by the Buick Motor Division of the General Motors Corporation, was capable of 7,800lb (3,538kg) dry-thrust (later versions developed 10,300lb (4,672kg) thrust with afterburning). Using two different engines meant that Lockheed was forced to design two different airframes because the J65 and J79 each required different engine air inlets and exhaust outlets. During the first eleven months of the flight test programme, the XF-104 prototypes averaged three flights per week and reached a maximum Mach number of 1.74 at 41,000ft (12,500m) which represented a True airspeed of 964 knots or 1,110mph (1,790km/h). The XF-104s were limited in Mach by the inlet temperature of the J65, and this would be true of the J79.

## *Production Processes*

Lockheed's design targets for the Starfighter included lightweight, conventional structure, and aerodynamic sleekness, as well as simpler maintenance (the F-104 had 165 interchangeable parts). These goals could only be achieved using some new fabrication methods such as cadmium plating, chemically milling, compression forming and zero draft forgings. Parts fabrication with tolerances as low as 0.010in were possible with contour forming, in which sheet metal was first shaped broadly, heat-treated, then precision formed in the cavity of a compression die. A high-pressure ram forced the metal to flow on both surfaces and edges of the part against the die face. Because of sharper flange bend radii, rivets could be seated almost in line with the web of wing stiffeners. This

**YF-104A-1 55-2955 first of the seventeen built for service trials with the GE 14,800lb (6,713kg) thrust J79-GE-3 turbojet. The YF-104As (and pre-production F-104As) had the fuselage lengthened from 49ft 2in (14.99m) to 54ft 8in (16.66m) and the tail surfaces moved aft. The first YF-104A was officially rolled out at Burbank on 16 February 1956. The next day the first YF-104A made its maiden flight, with Herm Salmon at the controls. On 27 April 1955 Maj Howard C. Johnson powered the YF-104A to Mach 2 for the first time.** Lockheed increased the connection's strength and cut down 'working' of the area under stress. Accuracy of compression forming eliminated waviness in wing panels that disturb airflow and promote unwanted friction and drag at high speeds. The same method was used with sheet metal for making wing spars and ribs that did not carry big loads.

The Starfighter's ailerons were made with a steel beam that had been heat-treated to an ultimate tensile strength of 180,000psi. Actuated by ten rods, the ailerons were hung on steel piano hinges. Both the nose landing gear and the main landing gear retracted into the fuselage because of the thin wing design. The wings were attached to the fuselage with five heavy forged fittings that were attached to wing skins and intermediate channels. Upper and lower skins were formed from single, machine-tapered plates, 0.25in (0.64cm) thick at the root and 0.125in (0.32cm) thick outboard.

Shaped exactly like the Starfighter's nose was a cone-like steel tool that wound fibreglass threads into distortion-free radomes. Spinning at a controlled speed, it pulled fibreglass strands through a resin bath and, under regulated tension, wove layers of glass thread into the radome. When threading and curing were completed, the radome was machined to exact dimensions by delicate cuts on the first and final layers. The electronically transparent nose was then checked for radar transmission characteristics with an interferometer and boresighted on the Lockheed radar range.

**XF-104-LO prototypes 53-7786 and 53-7787 in formation. 53-7787 (Company 1002), was used as the armament testbed and was armed with a single M-61 20mm multi-barrel gun. It could also mount a GAR-8 Sidewinder infrared air-to-air missile (or 170gal tip tank) at each wingtip. 53-7797 was lost in a crash on 14 April 1955 during a gunnery test flight when Herman 'Fish' Salmon was forced to eject because the ejection seat hatch on the floor blew out.** Lockheed

## Weapon System WS-303A

During January 1953 Lockheed's Model 83 design was selected by the Pentagon under Weapon System WS-303A, and on 12 March 1953 Letter Contract AF 33(600)-23362 for two XF-104 prototypes was submitted to Lockheed. The mockup was studied and led to the substitution of a rotary 6-barrelled 20mm General Electric M61 30mm Vulcan cannon mounted in the forward fuselage in place of the two 30mm cannon originally suggested by Lockheed. (Firing loads of the cannon were absorbed by a two-piece mount made of aluminium alloy forgings.) The mock-up was approved on 30 April 1953 and two production XF-104-00-LO prototypes (Model 083-92-01) were given the go-ahead.

The Korean War ended on 27 July 1953 and the US Air Force requirement for a high-performance air superiority fighter was no longer a priority. However, a new career unexpectedly opened up for the Starfighter. Air Defense Command had planned to replace the Convair F-102 Delta Dagger fighter-interceptor with the F-106 Delta Dart by 1954 but slippage had put these plans on hold. As a result Lockheed now changed the main mission for the XF-104 from that of an air superiority fighter to an air defence fighter-interceptor. This *volte face* made the F-104 appear a very attractive proposition, especially since it could fulfil a multi-role function with its ability to operate in the air superiority role when required. (The F-106 Delta Dart did not fly until 26 December 1956 and the first deliveries to Air Defense Command did not begin until July 1959, some five years later than planned.)

### *The Missile from Mojave*

The first XF-104 example (c/n 083-1001, serial 53-7786), was built in strict secrecy in January 1954 with no official roll-out party. It was physically different from the eventual production models in several respects. The XF-104 was shorter, at 49ft 2in (14.99m), as opposed to the 54ft 8in of the later Starfighters. The XF-104s neither had the inlet spikes (or cones) sported by their successors, nor the ventral fin. One of the distinguishing features of the prototype was the negative 10 degree dihedral angle of the wings. Maximum take-off weight of the X model was 18,530lb (8,400kg).

The XF-104 was transported by road to the Top Secret North Base Area at Edwards Air Force base in the Mojave Desert where Lockheed Chief Test Pilot, Tony LeVier, and test pilot Herm 'Fish' Salmon, were to put both prototypes through the essential test evaluation programme. LeVier began his career with Lockheed in 1941, became a test pilot in the P-38 Lightning programme, and was promoted to Chief Test Pilot in 1945. He made the first flights of the XP-80, T-33, F-94, T2V, F-104 and the U-2. Salmon, a well-known air racing pilot, had been involved with flight testing Lockheed's tail-sitting turboprop VTOL fighter concepts, the XFV-1, and America's first turboprop airliner, the Electra.

53-7786 (Company 1001) was to be used as the aerodynamic testbed while the second XF-104, 53-7787 (Company 1002), was to be used as the armament testbed. Challenges on this programme involved investigation of supersonic performance, flutter, stability, controllability, very little data on which existed at this time. Both XF-104 prototypes were originally equipped with roll and yaw axis stability augmentation systems (SAS). The roll SAS was flown in two different configurations, one in which a single aileron was used, the other involving both ailerons. The two-aileron configuration was adopted for use in later models.

Early problems with lateral directional stability resulted in the addition of a ventral fin, and longitudinal stability problems resulted in the addition of a pitch axis SAS. All subsequent F-104 models were equipped with three axis SAS systems. The first XF-104 was to be used to investigate static and dynamic stability in all three axes, stick force per G, stall characteristics, airspeed calibrations and powerplant thrust testing. Also, it would be used to evaluate all systems including air conditioning/pressurization, hydraulics, landing gear, brakes, fuel, flight controls and communications. Structural loads too would be measured. Instrumentation on the prototypes was crude by today's standards, but state-of-the-art for that time. Miller J oscillographs, Brown temperature recorders and photo panels were the primary recording devices used.

| **Specification – Lockheed XF-104** | |
|---|---|
| Model: | 083-1001/2 |
| Type: | Experimental aircraft |
| Crew: | Pilot only |
| First Flight: | 4 March 1954 (53-7786) |
| Number built: | 2 |
| Powerplant: | (XF-104 only). One Buick-built Wright Aeronautical XJ65-W-6 axial-flow turbojet. 7,800lb (3,538kg) dry-thrust (later versions developed 10,300lb thrust with (4,672kg) afterburning). (Both XF-104s after 1001 was re-engined): one Wright J65-W-7 axial-flow turbojet |
| Dimensions: | Span, without tip tanks, 21.94ft (6.69m); wing area, 196.10sq ft (18.21$m^2$); length, 49.17ft (15m); height, 13.49ft (4.1m) |
| Empty weight: | 11,500lb (5,216kg) |
| Gross weight: | 16,700lb (7,575kg) |
| Performance: | Mach 1.74 at 41,000ft (12,500m) |
| Armament: | One 20mm M-61 Vulcan rotary cannon *(XF-104-2 only)* |

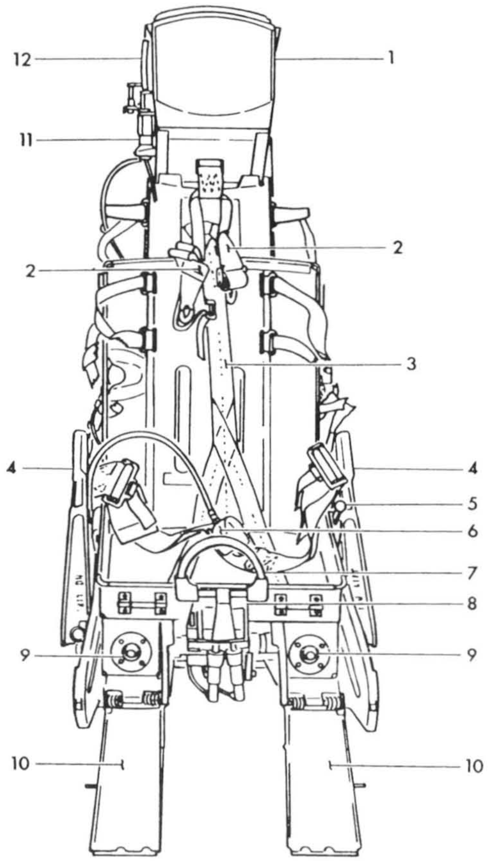
**Tony LeVier (left) and Herman 'Fish' Salmon, the two Lockheed test pilots most associated with the XF-104 Starfighter test programme.** Lockheed

## Going down in the World

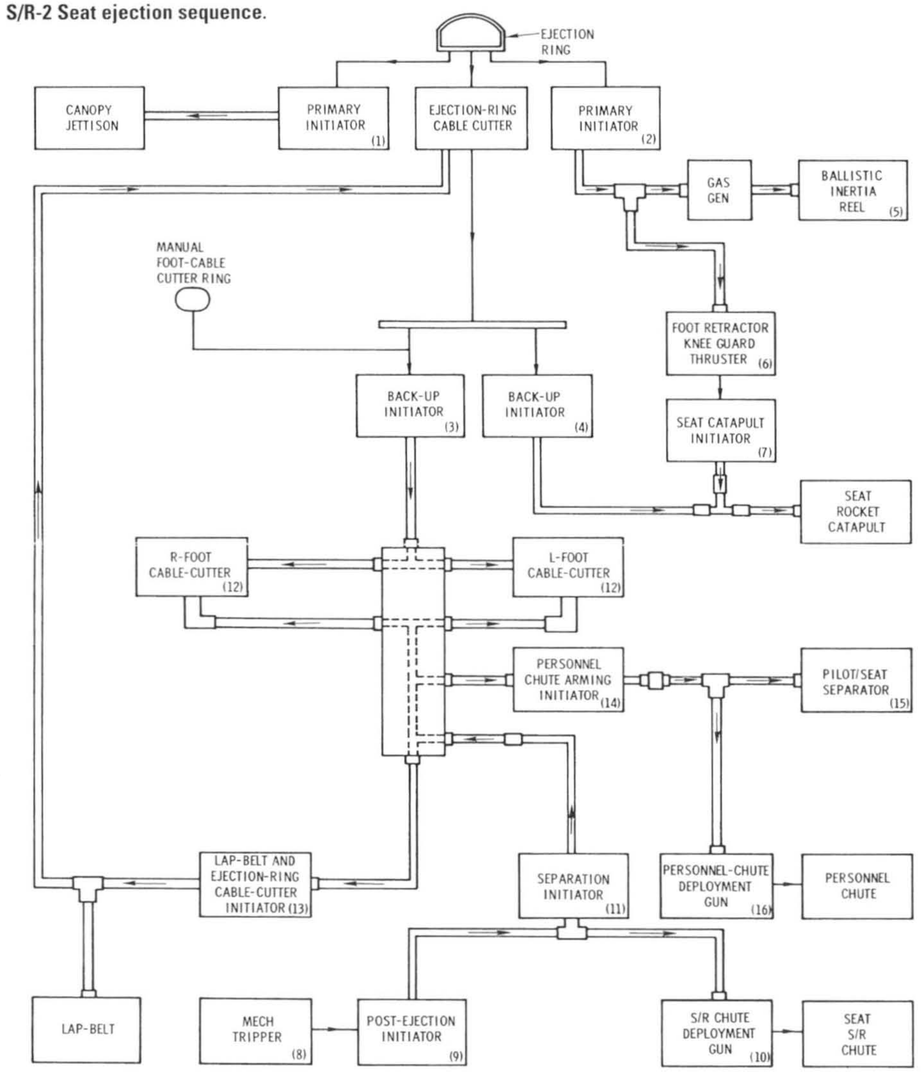
Because Lockheed engineers perceived a danger during upward ejection posed by the high T-tail, both XF-104s were fitted with a Lockheed-built downward-firing rocket-propulsion ejection seat system, the first fully automatic system used on any production fighter aircraft. Lockheed engineers also surmised that essentially, all ejections would be accomplished at altitudes high enough for successful completion of the downward ejection manoeuvre. The seat was designed so that after the pilot pulled the ejection ring the cockpit would depressurize and explosive bolts would blow the escape hatch off the bottom of the aircraft before the seat ejected downward and out. Obviously, the ejection sequence could not safely be used on the ground it was also only suitable for medium- to high-altitude emergencies. If the pilot needed to eject at low altitude therefore, he would have to roll the aircraft inverted (upside down) and then eject upward from the underside of the fighter!

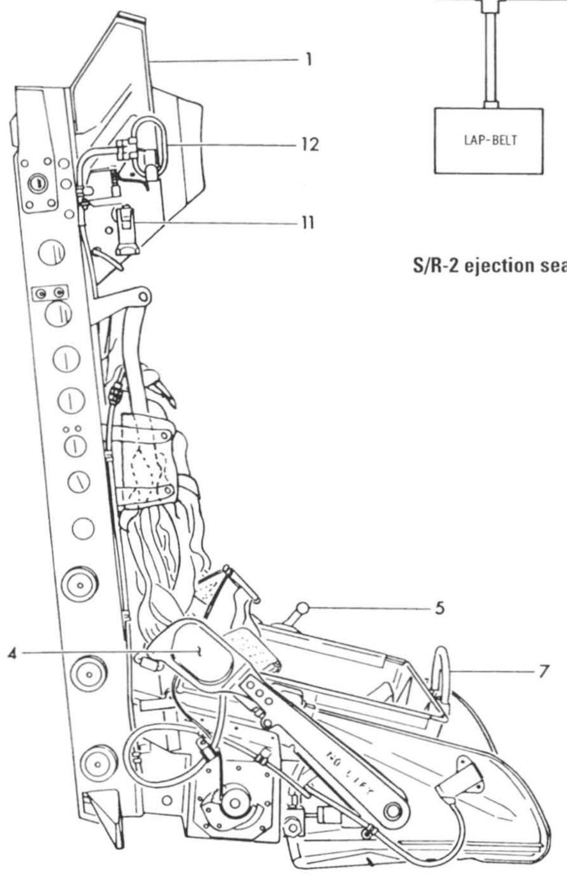
Eventually, it was proved that the engineers' worst fears concerning the XF-104's tail proved groundless and all Starfighters were fitted with an upward-firing ejection seat. First to be used was the rocket-powered Lockheed C-2 seat (which although it was quoted as 'zero-zero'-capable (zero speed and altitude), a forward speed of at least 98kt was required for successful ground level ejection). Lockheed promoted the C-2 seat thus:

> Capable of providing full recoveries at airspeeds from approximately 100–550 knots and altitudes from ground level to 50,000ft [15,240m] the C-2 leaves the Super Starfighter via a rocket-catapult device. At or near ground level the timing mechanism is set to separate pilot from seat one second after ejection – and parachute deployment one second later.
>
> To eject, the pilot pulls a D-shaped ring located between his feet on the seat bucket structure. The ring fires two initiators. One ejects the canopy. The other starts pre-ejection functions. In three-tenths of a second, this happens: Metal stirrups pull feet close to the body and hold them until time of man-seat separation. Knee guards rotate into position to prevent the leg spreading and to counteract effects of airloads. Arm support webbing flips up and prevents outward movement of arms. Moving up the rails, the seat hits a striker and – one second later – the lap belt is released, foot retention cables are cut and the pilot-seat reel operates. (Pulling the D-ring also operates a backup system that fires a delay initiator into the catapult unit and a second one into foot cutters.)
>
> The XM-10 rocket-catapult, a pyrotechnic propulsion unit, fits on the seat back upper cross-beam members and moves up and down with seat adjustment. Forcible separation is actuated pyrotechnically by a windup reel behind the head rest. Nylon webbing is routed from the reel down the forward face of the seat back, under the survival kit, and secured to the forward seat bucket lip. Sequenced with the lap belt release, the webbing is drawn taut between the head rest and the lip in two-tenths of a second, 'pushing' the pilot out and away from the seat one second after ejection.
>
> To assure proper foot retention and retraction, the pilot wears foot spurs equipped with ball sockets at the back. The ball lock end, engaged by spurs, is attached to cables that pull feet rearward and secure them in foot shelf units. Two initiators, fired one second apart, cut cables free at the proper time.
>
> Carried on the aluminium alloy seat is an automatic survival kit that includes disconnect



S/R-2 Seat ejection sequence.


EJECTION RING
CANOPY JETTISON
PRIMARY INITIATOR (1)
EJECTION-RING CABLE CUTTER
PRIMARY INITIATOR (2)
GAS GEN
BALLISTIC INERTIA REEL (5)
MANUAL FOOT-CABLE CUTTER RING
FOOT RETRACTOR KNEE GUARD THRUSTER (6)
BACK-UP INITIATOR (3)
BACK-UP INITIATOR (4)
SEAT CATAPULT INITIATOR (7)
SEAT ROCKET CATAPULT
R-FOOT CABLE-CUTTER (12)
L-FOOT CABLE-CUTTER (12)
PERSONNEL CHUTE ARMING INITIATOR (14)
PILOT/SEAT SEPARATOR (15)
LAP-BELT AND EJECTION-RING CABLE-CUTTER INITIATOR (13)
SEPARATION INITIATOR (11)
PERSONNEL-CHUTE DEPLOYMENT GUN (16)
PERSONNEL CHUTE
LAP-BELT
MECH TRIPPER (8)
POST-EJECTION INITIATOR (9)
S/R CHUTE DEPLOYMENT GUN (10)
SEAT S/R CHUTE



S/R-2 ejection seat.

1 headrest
2 shoulder harness
3 pilot seat separator
4 knee guard
5 inertia reel lock handle
6 automatic lap belt (HBU-4/A)
7 ejection ring
8 ejection ring safety pin
9 foot retainer ball assembly
10 foot ramp
11 deployment-gun arming cable connector
12 manual foot-cable cutter ring

hardware, automatic life raft inflation, high pressure emergency oxygen bottles with 15 minutes' duration, and a regulator suitable for partial pressure suits above 42,000ft.

The C-2 was used in all F-104s except for those built in Belgium, Germany, and the Netherlands. The C-2 was later replaced by the Lockheed S/R-2, which offered true zero-speed, zero-altitude capability, and after 1966, the Martin-Baker Mk G07(F) upward-firing ejection seat, was fitted to F-104s built in Belgium, Germany, and the Netherlands.

## First Flights

On 28 February 1954 XF-104 53-7786 made an unscheduled short and straight hop before LeVier flew the number one aircraft for the first time on 4 March. (53-7786 was lost in a crash on 11 July 1957). On 25 March 1955 XF-104-2 53-7787, now powered by an afterburning Wright J65-W-7, and flown by Lockheed test pilot Ray Goudey, reached a top speed of Mach 1.79 (1,324mph/2,130km/h). On 14 April 1955 this Starfighter was lost during a gunnery test flight when Herman 'Fish' Salmon was forced to eject because the ejection seat hatch on the floor blew out.

With sudden decompression, Salmon's pressure suit inflated, and he could not see what had happened but he believed that he had experienced a gun-firing mishap, as LeVier had earlier. (On LeVier's one of the bolts had blown out of the gun, penetrating a bulkhead and fuel cell aft of the gun bay. The gun bay door also partially opened, allowing fuel from the punctured cell to enter the engine inlet. LeVier had made a flame-out landing on the lakebed at Edwards AFB. Subsequent investigation of the airframe and gun indicated that high temperatures in the gun bay allowed a round to swell up such that it jammed in the barrel, causing the bolt to blow out when it fired). Salmon ejected and landed safely. (Salmon retired from Lockheed in 1968. He lost his life in the crash of a Lockheed L1049H Constellation while on a ferry flight from Columbus, Indiana, in 1980. LeVier retired from Lockheed in 1974 with over 10,000h in more than 250 different aircraft).

The XF-104 trials revealed that even with the afterburning version of the J65 turbojet, the production aircraft would not be able to reach design maximum speed. (On 8 June 1954 the XJ79-GE-1 was test-fired for the first time in a special test cell within General Electric's Evendale, Ohio, facility, and without afterburning, produced 9,290lb (4,214kg) thrust). In addition, directional stability problems manifested themselves and the need to carry more internal fuel load meant that the nose would have to be lengthened on the next batch of YF-104A service trial aircraft.

On 30 March 1955 the US Air Force placed an order for seventeen YF-104As against contract AF-27378. The YF-104s (and pre-production F-104As) had the fuselage lengthened from 49ft 2in (14.99m) to 54ft 8in (16.66m) and the tail surfaces moved aft. On the face of it, everything now seemed well starred for the future F-104. On 27 April 1955 Maj Howard C. Johnson powered the XF-104A to Mach 2 for the first time. By the end of 1955 Lockheed had an order for 155 F-104s for Air Defense Command.

The first YF-104A was rolled out from Shop B-1 at Burbank on 23 December 1955, but the appearance of the Starfighter was not made widely known until its first public roll-out, at Burbank on 16 February 1956. The next day the first

**Specification – Lockheed YF-104A**

| | |
|---|---|
| Model: | 183-93-02 |
| Type: | Experimental aircraft |
| Crew: | Pilot only |
| First Flight: | 17 February 1956 |
| Number built: | 17 |
| Powerplant: | One 9,600lb (4,354kg) static thrust, 14,800lb (6,713kg) afterburning General Electric J79-GE-3/-3A/-3B/-11A/-19 turbojet |
| Dimensions: | Span, without tip tanks, 21.94ft (6.69m); wing area, 196.10sq ft (18.21m$^2$); length, 54.77ft (16.69m); height, 13.49ft (4.1m) |
| Empty weight: | 12,780lb (5,797kg) |
| Gross weight: | 17,770lb (8,060kg) |
| Performance: | Max speed, Mach 2.23 |
| Armament: | One 20mm M-61 Vulcan rotary cannon; two AIM-9 Sidewinder AAMs |

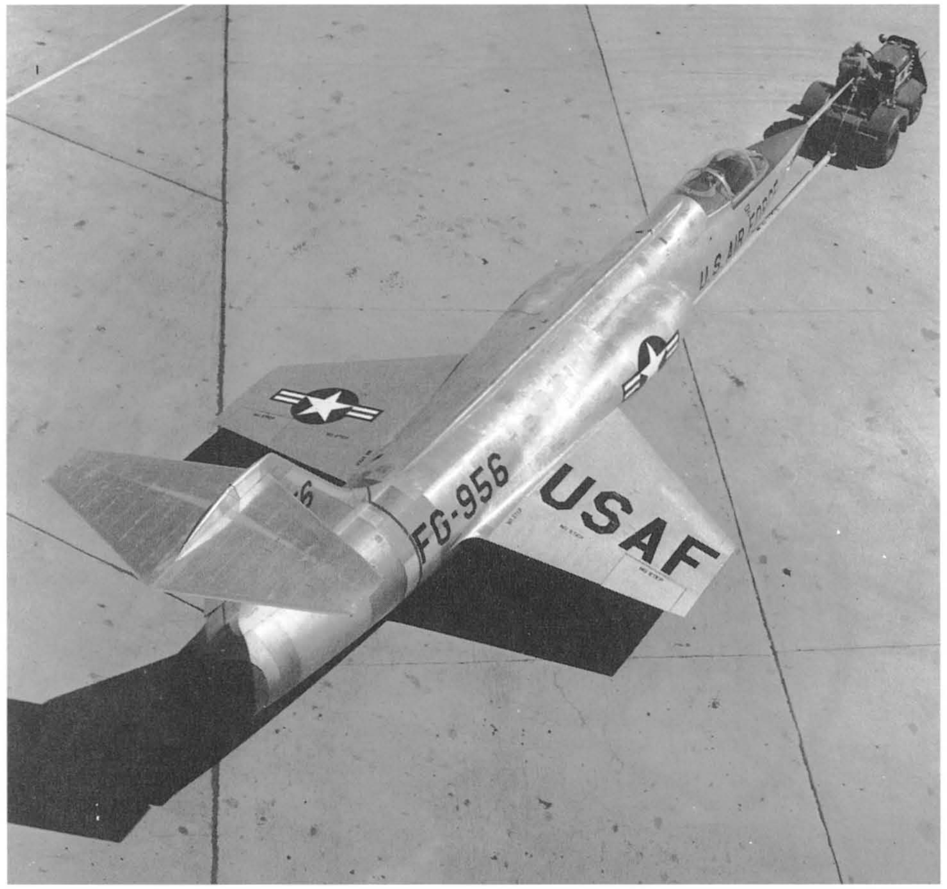
**Specification – Lockheed F-104A**

| | |
|---|---|
| Model: | 183-92-02 |
| Type: | Fighter-bomber |
| Crew: | Pilot only |
| First Flight: | 17 February 1956 |
| Number built: | 170 (17 YF-104A/7 pre-production F-104A/146 F-104A) |
| Powerplant: | One 9,600lb (4,354kg) static thrust, 14,800lb (6,713kg) afterburning General Electric J79-GE-3A/3B turbojet |
| Dimensions: | Span, without tip tanks, 21ft 9in (6.62m); wing area, 196.1sq ft (18.21m$^2$); length, 54ft 8in (16.66m); height, 13ft 5in (4.08m) |
| Empty weight: | 13,384lb (6,071kg) |
| Gross weight: | 22,614lb (10,258kg) |
| Combat weight: | 17,988lb (8,159kg) |
| Max take-off weight: | 25,840lb (11,721kg) |
| Performance: | Max speed, 1,037mph (1,669km/h) at 50,000ft (15,240m)<br>Cruising speed, 519mph (835km/h)<br>Climb in one minute, 60,395ft (18,408m)<br>Service ceiling, 64,795ft (19,750m)<br>Combat ceiling, 55,200ft (16,825m)<br>Range, 730 miles (1,175km)<br>Maximum range, 1,400 miles (2,253km) |
| Fuel: | Normal, 897 USgal (3,395l) |
| | Maximum, 1,627 USgal (6,158l) |
| Armament: | One 20mm M-61 Vulcan rotary cannon and two machine guns |

YF-104A made its maiden flight, with Herm Salmon at the controls. On 28 February the YF-104A, flown by Joe Ozier, exceeded Mach 2 for the first time.

On 2 March 1956, Lockheed received contract AF-30756 for seven pre-production F-104As. The contract also authorized the procurement of 146 F-104As and six tandem-seat F-104Bs for Air Defense Command, and fifty-six single-seat F-104C Starfighters for Tactical Air Command. (TAC needed a supersonic tactical strike fighter (fighter-bomber) to fill the gap between the North American F-100C Super Sabre and the Republic F-105B Thunderchief.) On 26 December 1956 Lockheed received a second order from Tactical Air Command, for a further twenty-one F-104Cs.

The YF-104As were to flight-test and evaluate the three early versions of the 14,800lb (6,713kg) General Electric YJ79-GE-3, -3A, and -3B turbojet series. (Unfortunately, the J79 made no provision for modulated afterburning and pilots soon found that bringing in the afterburner took them straight from Mach 1 to Mach 2.2 with no ability to stabilize at any speed in between! In addition, once they reached Mach 2.2, the engines began overheating and they had to return to Mach 1 again). Apart from exploring the entire performance envelope and testing the new canon armament, from April 1956 the YF-104As also would have to test the relatively new AIM9 (formerly GAR-8) Sidewinder air-to-air heat-seeking missile. Without such armament the Starfighter would be no use in an air defense role.



*(Left)* **YF-104A-2 55-2956 being towed out at Edwards. The YF-104As were to flight-test and evaluate the three early versions of the 14,800lb (6,713kg) General Electric YJ79-GE-3, -3A, and -3B turbojet series. From April 1956 the YF-104As also would have to test the relatively new AIM9 (formerly GAR-8) Sidewinder air-to-air heat-seeking missile. On 28 February 1956 the YF-104A, flown by Joe Ozier, exceeded Mach 2 for the first time. After being used for testing, 55-2956 became a QF-104A drone.** Lockheed

*(Below)* **Tied down and chocked, YF-104A-11 55-2965 in full 14,800lb (6,713kg) afterburner thrust during a night engine run at Edwards AFB, California in May 1957.** Lockheed

Further refinements included the fitting of variable shock-control semitone, or ramp, in the fuselage-side air intakes to channel the huge amount of secondary airflow at supersonic speed. A forward-retracting undercarriage was installed in place of the rearward-retracting arrangement. (XF-104 53-7786 had experienced undercarriage retraction problems on its first flight on 5 March). Also, a brake-chute and an arrestor hook were introduced, and a ventral fin positioned on a level with the afterburner was added to improve stability.

However, while these improvements were successful, lingering problems in perfecting the afterburner for the J79 and other setbacks, would only serve to delay the Starfighter's introduction to operational service. On 24 April 1956 Flight Test Center commander Brig Gen J. Stanley Holtoner advised Air Force Systems Command commander Lt Gen Thomas A. Power that there had been a slippage in the flight-test programme of the YF-104A because of compressor problems with the J79 turbojet. There were also other problems to contend with, ones which would produce serious question marks over the Starfighter's ability to operate as an interceptor. By early June 1956 Holtoner had concluded that with internal fuel only, limited endurance and radius of action 'posed serious problems for use in any proposed tactical role' and that the F-104, using internal fuel only, had 'an intercept radius of 150 miles against a B-52 type target at 45,000ft'. This would mean that intercepts at 70,000ft would 'have to be made over the base'.

## Special Weapon Configuration

While this situation was very disquieting news for Air Defense Command, which was scheduled to receive operational F-104As before Tactical Air Command, the latter had a requirement for its F-104Cs to carry the two types of US nuclear payloads. One type was the 2,013lb (913kg) B28 (formerly T28), which measured 170in (4.3m) long and 20in (51cm) in diameter, and was designed to be dropped from high altitude at subsonic or supersonic speeds. The other was the 2,195lb (996kg) B28-1 (formerly T28-1), a parachute-drop bomb, which was 175in (4.4m) long, 20in (57cm) in diameter, and which was designed to be delivered at low altitude under high-g conditions (using the low-altitude bomb system of LABS). The Starfighter would be required to carry a nuclear store externally as well as wingtip and/or underwing auxiliary fuel tanks.

Since single-seat F-104C aircraft were not yet available – by December 1956 – for the Special Weapon Configuration testing, F-104A 56-0801 was used for the performance phase and F-104A 56-0790 for the stability phase. Both F-104As were modified to carry ventral bomb racks to carry the nuclear device. Additional fuel would be carried externally also, in two 165-gal wingtip tanks and in two 200-gal underwing pylon mounted tanks. Internal fuel added another 908gal.

Not unsurprisingly, the Special Weapon Configuration programme, which was carried out over 37 flights totalling 37hr 30mins at Palmdale and at Edwards, revealed serious fuel limitations and a dramatic fall off in the Starfighter's overall speed and distance performance. The tests involving a Starfighter carrying a total of 1,638gal fuel (i.e. with four external fuel tanks in addition to the internal fuel) and a 'special store', reduced the afterburning sea level rate of climb to 23,400ft/min (7,132m/min) compared to 36,400ft/min (11,095m/min) for the clean aircraft.

Also, supersonic capability was no longer possible with the carrying of the five external stores, although about Mach 1.2 could be achieved if the underwing fuel tanks were removed. If the F-104 dropped its external fuel tanks as they became empty in a typical subsonic strike mission, the nuclear bomb could be delivered onto a target 828 miles (1,332km) from the home base and the aircraft returned safely. It might have been prudent to drop the tanks on any such mission anyway as it was found that the aircraft fishtailed at speeds above 675mph (1,086km/h) IAS (indicated air speed) when any of the external tanks *and* the nuclear store were carried. Hence, the F-104 pilot would not be able to rely on supersonic performance on any nuclear strike mission. The best he could hope for while carrying the store would be a maximum flight speed using military power of about Mach 0.965 at 20,000ft (6,096m) and Mach 0.945 at 35,000ft (10,668m). Clearly, the Starfighter would have severe limitations to say the least, if it were used in the nuclear strike role!

## Testing Continues

Other problems manifested themselves during the flight-test programme. (YF-104A-6 (55-2960) was destroyed in a crash on 3 November 1956, and YF-104A-4 (55-2958) was lost on 15 February 1957.) Altitude errors noted in the transonic speed area during trimmability tests led to such novel test procedures as flying alongside another aircraft's level contrail to maintain a constant altitude!

By 5 December 1956, when seventeen YF-104As and seven F-104As had been delivered to the Flight Test Center, it was evident to the flight-test personnel that although the Starfighter promised spectacular speed and climb performance, problems of pitch-up, and delays generally caused by the need to develop and fit wingtip and underwing tanks, and produce an adequate armament system would 'relegate the early production aircraft to little more than a training role'. Furthermore, flight-testing of ten early production F-104As for Phase VI functional development and Phase IV performance and stability tests, were still to take place, in 1957.

Not least of the Starfighter's problems was pitch-up at high angles of attack. On 1 May 1957 the eighth YF-104A (55-2962) became the fourth test Starfighter lost. Lockheed experimental pilot Jack J. 'Suitcase' Simpson was just forty seconds into the test, at 30,000ft (9,140m) the first test point on airspeed, angle of attack and yaw input, when the 'Eight Ball', as it was named, snapped into a pitch-up and inverted nose down roll. Simpson managed to regain control and level out after taking 9,000ft (2,740m) to recover and after reaching the required height, decided he would try the test again. As soon as he tried to hold the angle of attack the Starfighter again went into pitch-up. It stalled out and Simpson was about 60 degrees upside down and yawing. The engine though had not flamed out (on more than a dozen occasions previously it had) and finally Simpson was able to level out once more after losing 16,000ft (4,870m) of precious altitude.

He headed back to the dry lake bed at Edwards resolving to avoid any pitch-up, yaw and roll situations. (A Lockheed test pilot had been killed in the crash of 55-2958 on 15 February during a flare-out on landing – the 'eating the ice cream cone' manoeuvre used to decrease sink rate just prior to touchdown. The YF-104A had pitched up and catapulted while rolling to the right.) Simpson, who was now at 31,000ft (9,450m), on the letdown, declared an emergency and requested a landing on Harper Dry Lake bed. He started to lose altitude and had descended to 29,000ft (8,840m) when he ran into a rumble of clear-air turbulence. He inched back on the throttle and instinctively closed the speed brakes to reduce buffet. As he looked down to check the airspeed indicator, the nose violently pitched almost straight down and continued to move through 90 degrees. (Later, it was determined that an incorrectly installed tip tank had been torn loose in the clear-air turbulence and had then jammed itself into the tail and sliced through it.) Simpson waited not a moment longer. He reached down and pulled the ejection ring between his legs with both hands and pulled as the Eight Ball continued to tumble. Simpson ejected upward, upside down at 17,000ft (8,230m). He lived to tell the tale (three of his fellow test-pilots were killed in the YF-104 when they were forced to eject at low altitude or too near to the ground).

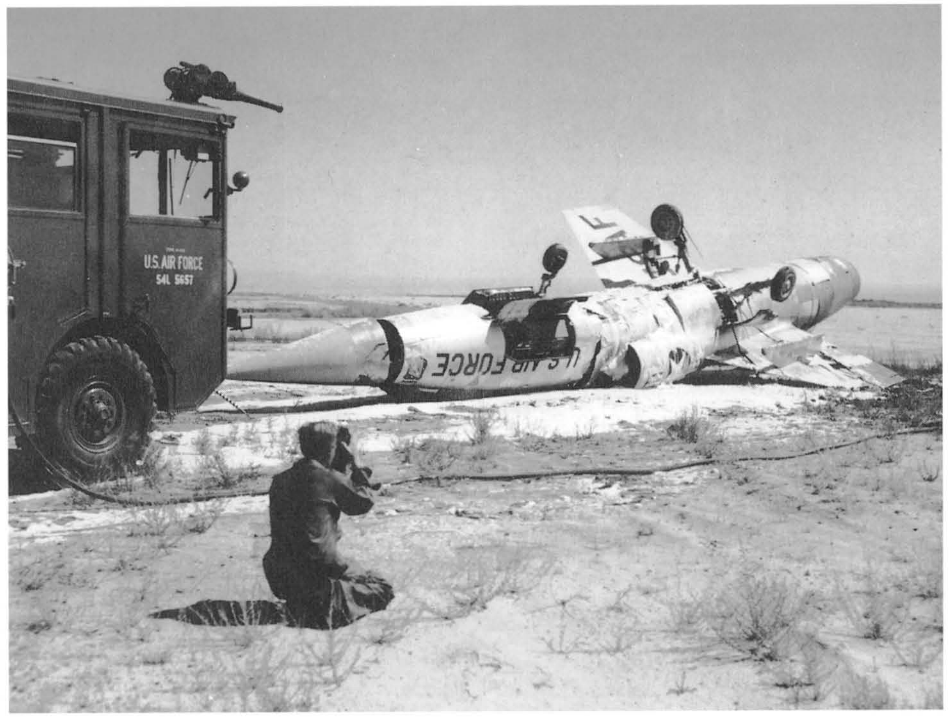
A few weeks later, on 27 May, YF-104A-16 (55-2970) was lost in a crash and a year later, on 6 May 1958, the fourteenth YF-104A (55-2968) was written off. Another sad loss, on 26 July 1958, was Captain Iven C. Kincheloe, who was killed in a flying accident at Edwards AFB while piloting F-104A-15 56-772. Kincheloe had received the 1956 Mackay Trophy for setting an altitude record of 126,000ft (38,405m) in the Bell X-2 in September 1956. At the time of his death he was one of three pilots selected to fly the X-15.

Altogether, eight service test air vehicles, including the two XF-104s, were destroyed during the period of Starfighter testing, 1955–November 1959.

## US Navy Testing

In 1959 the US Navy at Navy Weapons Training Center (NWTC) China Lake were loaned three YF-104A/F-104As to test the effectiveness of the AIM-9 Sidewinder air-to-air missile at supersonic speeds. (At this time the Navy was still awaiting delivery of its own high-performance jets such as the Chance Vought F9U Crusader). Testing using YF-104A-2 (55-2956) and two F-104As (56-0740 and 56-0757), all of which were crewed by US Air Force personnel from the 83rd Fighter Interceptor Squadron, began in 1959 although the majority of the Sidewinder missile test firings took place during 1960 and 1961. The YF-104 completed the AIM-9 test programme safely and later became a QF-104A drone, but F-104A 56-0740 crashed at China Lake on 22 September 1960 and 56-0757 was also lost when it crashed on 7 April 1961.

***(Above)* Lockheed test pilot Herman 'Fish' Salmon poses for the camera beside the F-104A. Note the closed-over inlet ducts.** Lockheed



**YF-104A-17 55-2971 after its fourteenth barrier run test at Edwards AFB on 1 October 1958. Lockheed test pilot Jim Wood escaped. The aircraft was converted later to a QF-104A target drone for use by the 3205th Drone Squadron.** USAF via Robert F. Dorr

CHAPTER TWO

# In the Ascendancy

## USAF Service 1958–75

*Thank you, one and all, for the best airplane I've ever flown. The F-104 really shines. It is so simple to maintain, people with little experience can do it.*

Captain Charles E. Tofferi, 479th Tactical Fighter Wing who flew his F-104C to the 1962 William Tell Fighter Weapons Meet title

Originally, the F-104A was intended to equip Tactical Air Command where it was to replace its F-100 Super Sabres beginning in 1958, but delays in Starfighter delivery and a more urgent requirement by Air Defense Command for a fighter-interceptor changed all this.

## First Deliveries

The first batch of F-104As was delivered (as an interim measure pending delivery of the F-106 Delta Dart), to Air Defense Command on 26 January 1958, and the 83rd Fighter Interceptor Squadron at Hamilton AFB, California, near San Francisco, became operational on 20 February. The 83rd FIS also became the first unit to receive the F-104B two-seat trainer version of the Starfighter, in early 1958. However, just three months after going into service the squadron's F-104As were grounded after a succession of accidents caused by compressor stall and flame-out of the J79 turbojet engine. When this happened not only did the F-104 lose power, extremely critical in an aircraft with such high wing loading, but it also lost engine-driven flap-blowing. At low altitudes this was usually fatal. (Blown flaps for both leading and trailing edges had to be adopted for the F-104A. This provided a thin sheet of very high energy air, preventing breakaway and separation, increasing lift and reducing crucial stalling speed by 15 knots. Landing speed of the F-104 was high for its time, nearly 150 knots and its sink rate on the approach was considerable.)

The Starfighters remained grounded for three months while a new General Electric -3B engine was fitted. During 1958, three other ADC units were equipped with

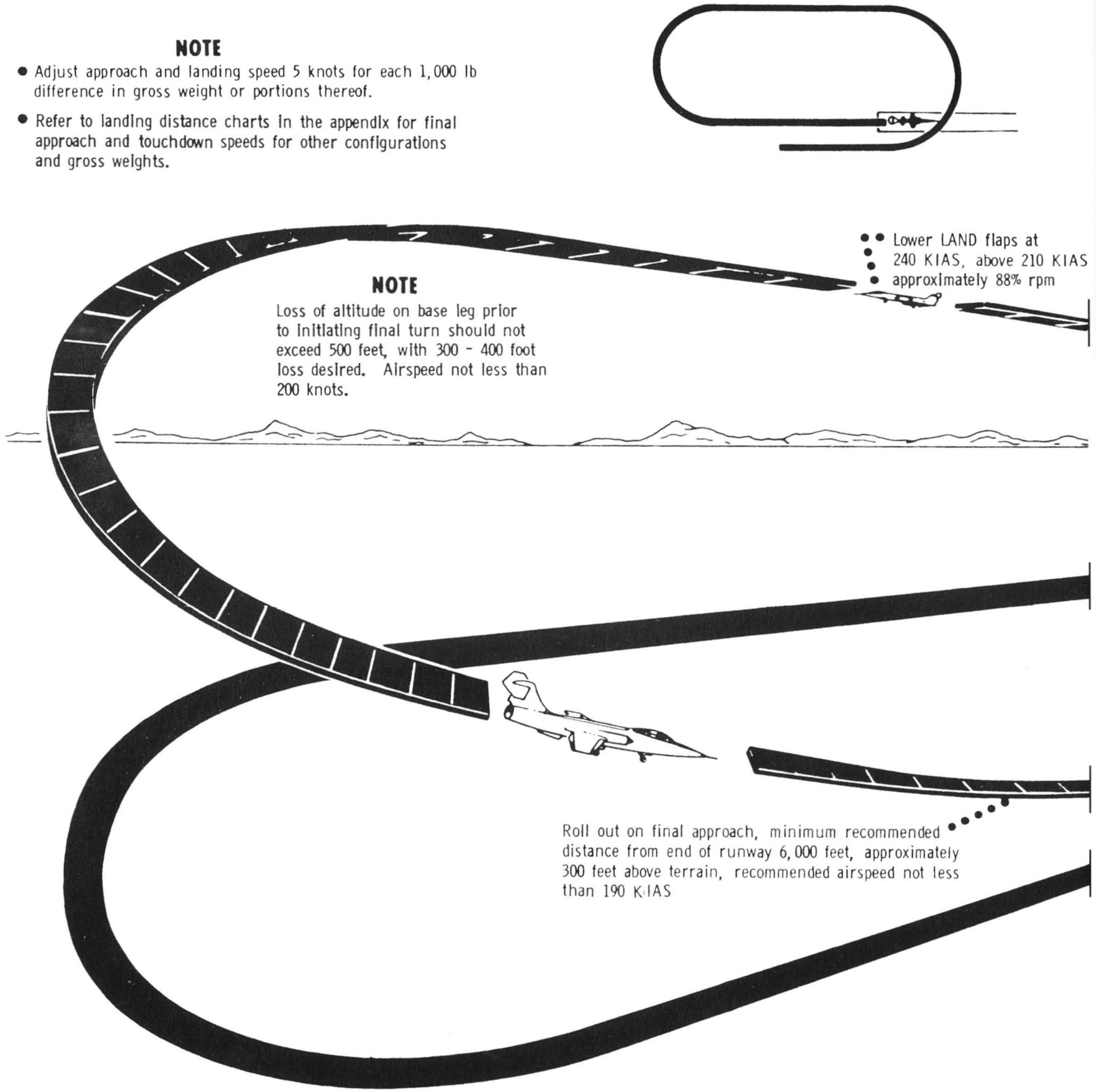
**F-104A-1-LO 56-735 of Air Defense Command. The first batch of F-104As was delivered to ADC on 26 January 1958, and the 83rd Fighter Interceptor Squadron at Hamilton AFB, California, near San Francisco, became operational on 20 February.** Lockheed

# TYPICAL LANDING PATTERN

Based on a gross weight of 16,100 lb.

**NOTE**

- Adjust approach and landing speed 5 knots for each 1,000 lb difference in gross weight or portions thereof.
- Refer to landing distance charts in the appendix for final approach and touchdown speeds for other configurations and gross weights.

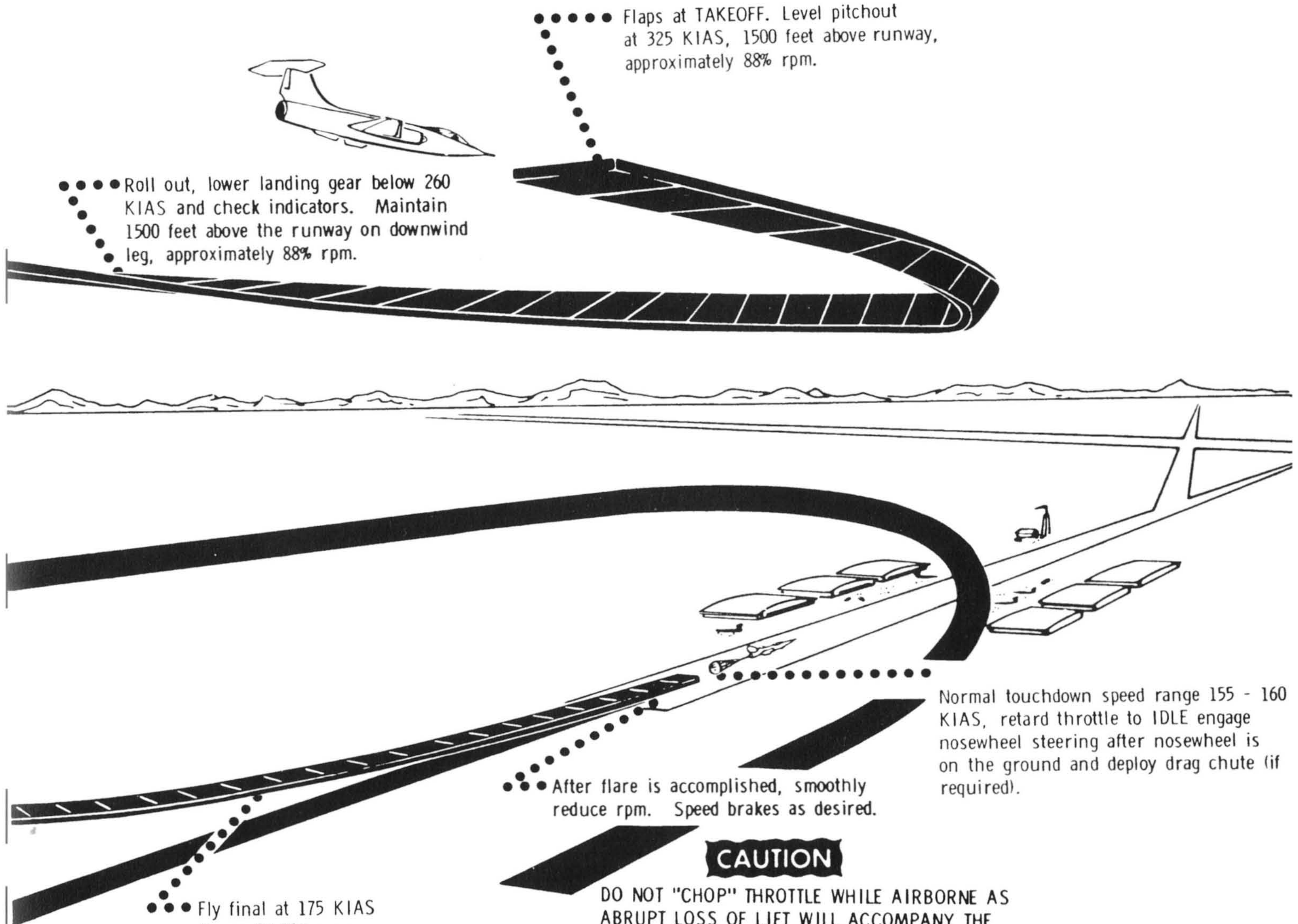


Lower LAND flaps at 240 KIAS, above 210 KIAS approximately 88% rpm

**NOTE**

Loss of altitude on base leg prior to initiating final turn should not exceed 500 feet, with 300 - 400 foot loss desired. Airspeed not less than 200 knots.

Roll out on final approach, minimum recommended distance from end of runway 6,000 feet, approximately 300 feet above terrain, recommended airspeed not less than 190 KIAS



Flaps at TAKEOFF. Level pitchout at 325 KIAS, 1500 feet above runway, approximately 88% rpm.

Roll out, lower landing gear below 260 KIAS and check indicators. Maintain 1500 feet above the runway on downwind leg, approximately 88% rpm.

Normal touchdown speed range 155 - 160 KIAS, retard throttle to IDLE engage nosewheel steering after nosewheel is on the ground and deploy drag chute (if required).

After flare is accomplished, smoothly reduce rpm. Speed brakes as desired.

Fly final at 175 KIAS Power 87-90% rpm.

**CAUTION**

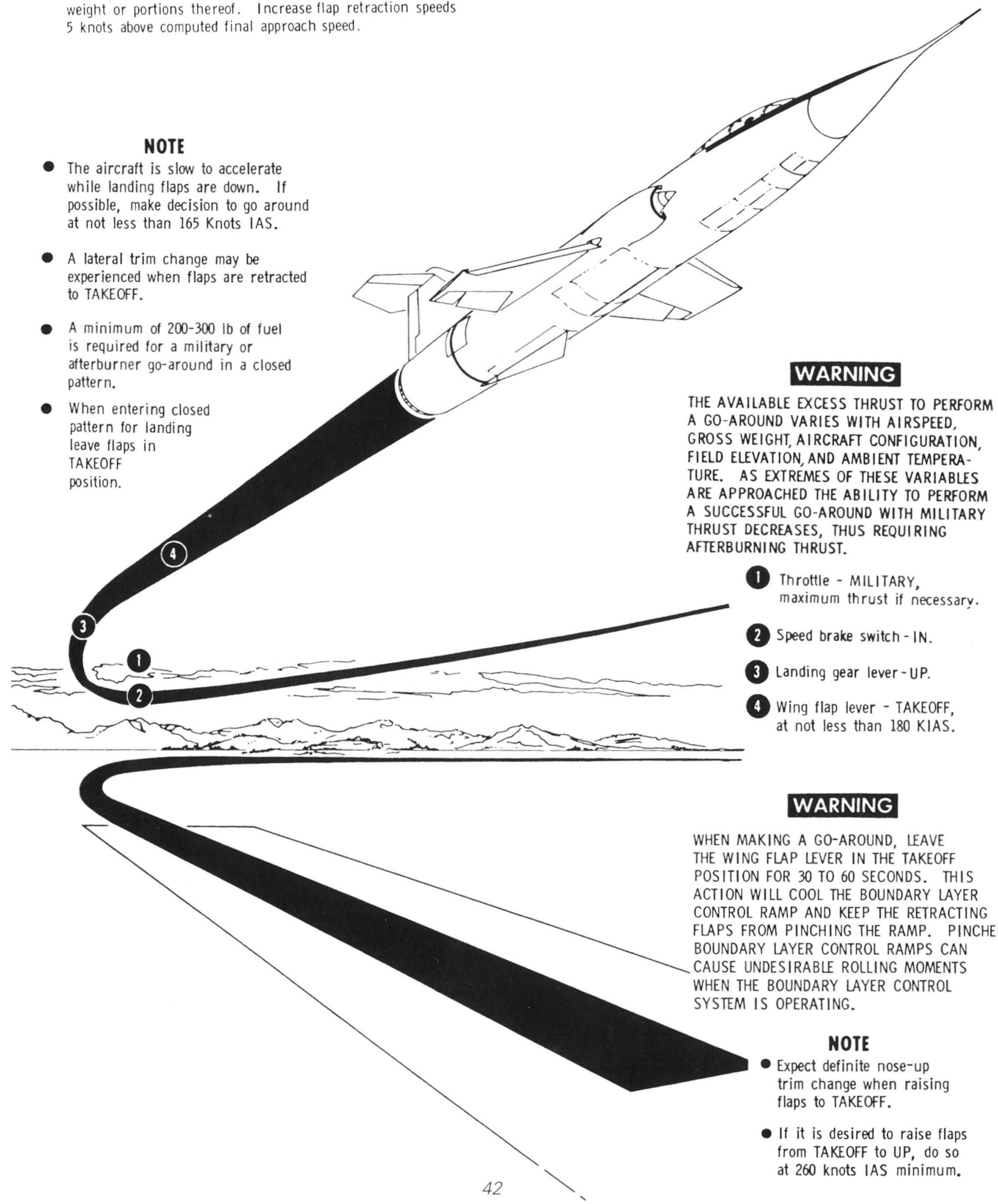
DO NOT "CHOP" THROTTLE WHILE AIRBORNE AS ABRUPT LOSS OF LIFT WILL ACCOMPANY THE DECREASE IN BOUNDARY LAYER CONTROL AIRFLOW.

**CAUTION**

- STEEP FINAL APPROACHES CAN BE HAZARDOUS IF THE AIRSPEED DROPS BELOW NORMAL, TURNS ARE MADE, OR GUSTY WINDS PREVAIL. THESE FACTORS MAY CAUSE AN EXCESSIVE RATE OF SINK WHICH WILL NOT BE RECOGNIZED AND CORRECTED BEFORE CONTACT WITH THE GROUND.
- ALL FINAL APPROACHES SHOULD BE MADE WITH POWER, AND ON A GLIDE SLOPE SIMILAR TO THAT FOR ILS/PAR ( 700-800 FEET PER MINUTE ). THIS SLOPE MAY BE INTERCEPTED AT ANY POINT, BUT SHOULD BE INTERCEPTED AT NOT LESS THAN ONE MILE FROM TOUCHDOWN.

# TYPICAL GO-AROUND

Based on a gross weight of 16,100 lb. Adjust approach and landing speeds 5 knots for each 1,000 lb. difference in gross weight or portions thereof. Increase flap retraction speeds 5 knots above computed final approach speed.



**NOTE**

- The aircraft is slow to accelerate while landing flaps are down. If possible, make decision to go around at not less than 165 Knots IAS.
- A lateral trim change may be experienced when flaps are retracted to TAKEOFF.
- A minimum of 200-300 lb of fuel is required for a military or afterburner go-around in a closed pattern.
- When entering closed pattern for landing leave flaps in TAKEOFF position.

**WARNING**

THE AVAILABLE EXCESS THRUST TO PERFORM A GO-AROUND VARIES WITH AIRSPEED, GROSS WEIGHT, AIRCRAFT CONFIGURATION, FIELD ELEVATION, AND AMBIENT TEMPERATURE. AS EXTREMES OF THESE VARIABLES ARE APPROACHED THE ABILITY TO PERFORM A SUCCESSFUL GO-AROUND WITH MILITARY THRUST DECREASES, THUS REQUIRING AFTERBURNING THRUST.

1 Throttle - MILITARY, maximum thrust if necessary.

2 Speed brake switch - IN.

3 Landing gear lever - UP.

4 Wing flap lever - TAKEOFF, at not less than 180 KIAS.

**WARNING**

WHEN MAKING A GO-AROUND, LEAVE THE WING FLAP LEVER IN THE TAKEOFF POSITION FOR 30 TO 60 SECONDS. THIS ACTION WILL COOL THE BOUNDARY LAYER CONTROL RAMP AND KEEP THE RETRACTING FLAPS FROM PINCHING THE RAMP. PINCHED BOUNDARY LAYER CONTROL RAMPS CAN CAUSE UNDESIRABLE ROLLING MOMENTS WHEN THE BOUNDARY LAYER CONTROL SYSTEM IS OPERATING.

**NOTE**

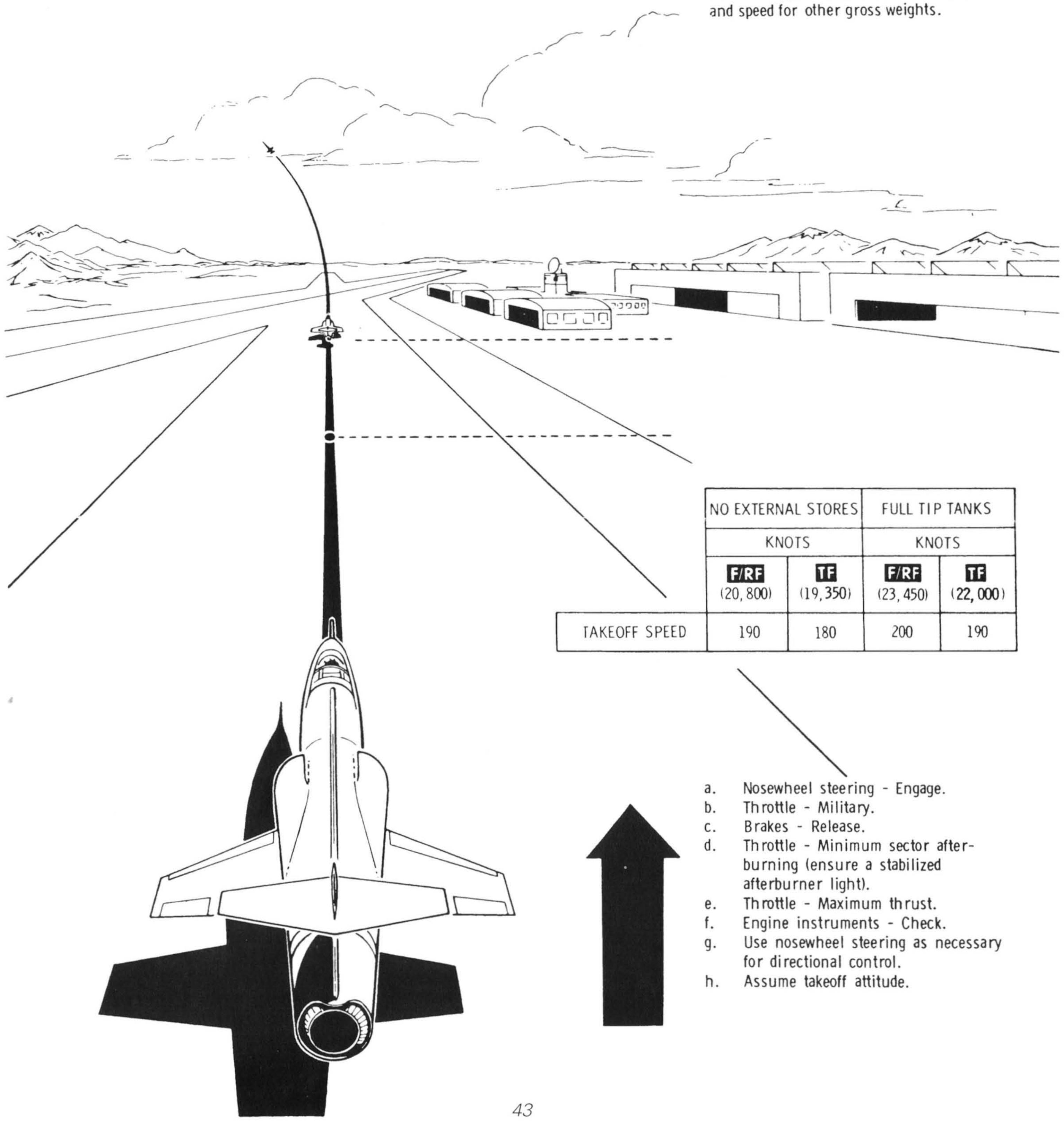
- Expect definite nose-up trim change when raising flaps to TAKEOFF.
- If it is desired to raise flaps from TAKEOFF to UP, do so at 260 knots IAS minimum.

---

# TYPICAL TAKEOFF

**NOTE**

- Necessary engine instrument checks, when using the afterburner, must be made during the initial portion of takeoff roll because the airplane cannot be held with the brakes.
- Refer to Appendix for takeoff distances and speed for other gross weights.



| | NO EXTERNAL STORES | | FULL TIP TANKS | |
|---|---|---|---|---|
| | KNOTS | | KNOTS | |
| | **F/RF** (20,800) | **TF** (19,350) | **F/RF** (23,450) | **TF** (22,000) |
| TAKEOFF SPEED | 190 | 180 | 200 | 190 |

a. Nosewheel steering - Engage.
b. Throttle - Military.
c. Brakes - Release.
d. Throttle - Minimum sector afterburning (ensure a stabilized afterburner light).
e. Throttle - Maximum thrust.
f. Engine instruments - Check.
g. Use nosewheel steering as necessary for directional control.
h. Assume takeoff attitude.

**F-104A-10-LO 56-750 at Edwards AFB, California. During 1958, three other ADC units were equipped with F-104As and F-104Bs. In April the 337th FIA at Westover AFB, received its Starfighters, and in June, the 538th FIS at Larson AFB, Washington, was also so equipped. In July the 56th FIS at Wright-Patterson AFB, Ohio, became the fourth and final Starfighter squadron in Air Defense Command.** Lockheed

F-104As and F-104Bs. In April the 337th FIA at Westover AFB, received its Starfighters, and in June, the 538th FIS at Larson AFB, Washington, was also so equipped. In July the 56th FIS at Wright-Patterson AFB, Ohio, became the fourth and final Starfighter squadron in Air Defence Command.

### *Operation* Jonah Able

In October 1958, in Operation *Jonah Able*, twelve F-104As of the 83rd FIS were disassembled, crated and airlifted by USAF Douglas C-124 Globemasters, on temporary deployment to Kungkwan Air Base, Taiwan. (Although a few F-104As had been fitted with an experimental air refuelling probe, none of the production batch were fitted with the device). They were needed to augment the forces of General Chiang Kai-shek's Nationalist China's air defence during the Quemoy/Matsu Crisis with the People's Republic of China.

Deliveries of the Starfighter to ADC (later Aerospace Defense Command) continued until December 1958 when the final eight F-104As of the 153 built were delivered. The Pentagon had provided the bulk of the $30 million cost of the 4-year F-104 flight test programme so they might have been expected to persevere with the F-104. However, they decided otherwise and to cut their losses. By December 1958 the USAF reduced its Starfighter procurement from a total of 722, to just 296.

***(Below)* F-104A-25-LO 56-842, one of the Starfighters of the 83rd FIS disassembled for airlift by USAF Douglas C-124 Globemasters to Kung-kwan Air Base, Taiwan, 12 September 1958.** USAF

The F-104A had the speed and the altitude to deter an aggressor, but the anticipated early availability of more flexible supersonic fighters, and the lack of an all-weather radar capability led to a review of the entire F-104 programme. (Lockheed had tried, unsuccessfully, to install the radar sight system in the needle nose and it had proved totally inadequate in range and power – on a good day it had a radar sight range of between five to ten miles. The type of radar required for a supersonic interceptor capable of Mach 2+, if it was to be effective, was too big and heavy for the F-104.)

**On Wednesday 7 May 1958 the F-104 became the first aircraft to hold World Airspeed and Altitude records simultaneously when Maj Howard C. Johnson (centre) of the 83rd Fighter Interceptor Squadron, Air Defense Command, at Hamilton AFB, California, reached 81,249ft (27,813m) in YF-104A-LO 55-2957 at Edwards AFB. (On 27 April 1955 Major Johnson had powered the XF-104A to Mach 2 for the first time). Left is Charles S. Logsdon, who headed the team of National Aeronautic Association representatives. Right is Col C.E. Cole, USAF plant representative at Lockheed.** Lockheed

**Maj Howard C. Johnson of the 83rd FIS receives congratulations for his 7 May record-breaking World Altitude Record flight from Capt Walter W. Irwin (left) and Capt James Low (right).** Lockheed

### *Records and Plaudits*

However, the Starfighter did achieve considerable fame in 1958–59 with a series of outstanding record achievements. In 1958 the F-104 became the first aircraft to hold World Airspeed and Altitude records simultaneously. First, on 7 May 1958, Maj Howard C. Johnson of the 83rd Fighter Interceptor Squadron reached 91,249ft (27,813m) at Edwards AFB. Then, on 16 May Captain Walter W. Irwin set a world air speed record of 1,404.19mph (2,259.34km/h) over a 15/25km course at Edwards AFB. On 18 December 1958, the Starfighter set more records. Flying from NAS Point Magu, California, an F-104A set three time-to-climb records: 3,000m (9,842ft) in 41.35sec; 15,000m (49,212ft) in 2min 11.1sec; and 25,000m (82,020ft) in 4min 26.03sec.

On 14 December 1959 an F-104C piloted by Captain Joe Jordan, Edwards AFB test pilot, beat the 1958 Starfighter height record, reaching 103,389ft (31,513m), making the Starfighter the first aircraft taking off on its own power to exceed the 30,000m and 100,000ft marks. Hitting a top speed of 1,400mph (2,253km/h), the F-104C also established a 30,000m time-to-climb mark of 5min 4.92sec, and even surpassed the existing balloon record of 101,516ft (30,942m).

For his design work on the aircraft, Johnson received the prestigious Collier Trophy in 1959 from the American Institute of Aeronautics and Astronautics.

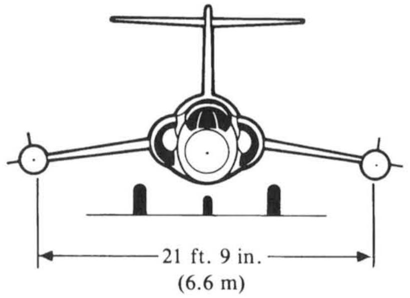
### *Phase-Out*

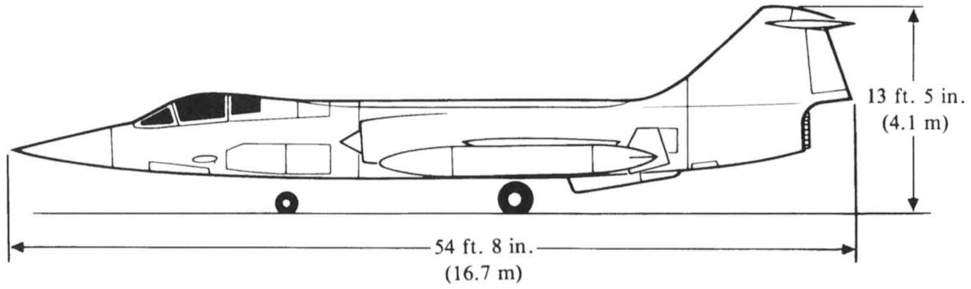
Disastrously for Lockheed, only 153 F-104As were built, and just twenty-six F-104B trainer versions, the first flying on 7 February 1957. (Lockheed ultimately produced just 277 F-104A/B/C/Ds for the USAF). F-104As and -Bs equipped the 83rd, 56th and 337th Interceptor Squadrons for less than a year before they were handed over to the 151st, 157th and 197th Squadrons of the Air National Guard, although later some F-104As, fitted with the GE-19 engine, returned to first-line service. Twenty-four F-104As were converted to QF-104 target drones, while three were modified to NF-104A models. Boosted by a 6,000lb (2,722kg) Rocketdyne AR-2 auxiliary rocket engine, they zoomed astronauts

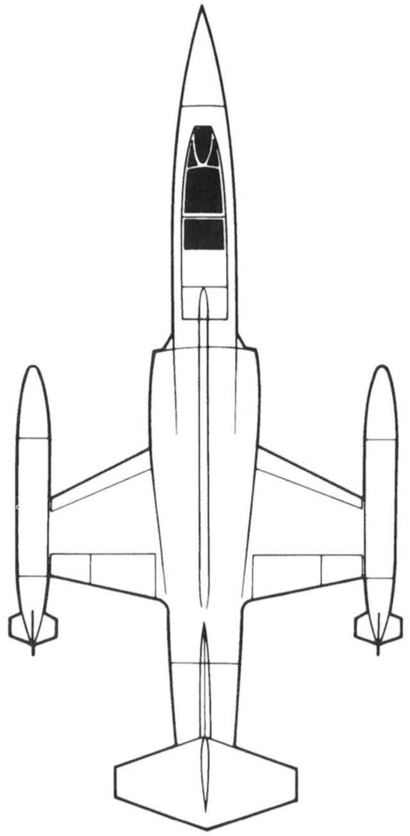
**(Above and left)** **Nine days after Johnson's successful flight, on 16 May 1958, Capt Walter W. Irwin of the 83rd FIS, in YF-104A 55-2969, set a world air speed record of 1,404.19mph (2,259.34km/h) over a 15/25km course at Edwards AFB. After being used for testing 55-2969 was converted to a QF-104A drone. It was written off on 22 August 1957.** Lockheed

**(Above)** **On 14 December 1959 F-104C 56-0885 piloted by Captain Joe Jordan, Edwards AFB test pilot, seen here being congratulated by Tony LeVier, beat the previous Starfighter height record, reaching 103,389ft (31,513m), thus becoming the first aircraft taking off on its own power to exceed the 30,000m and 100,000ft marks.** Lockheed

**Captain Joe Jordan posing for the camera atop his Starfighter. Hitting a top speed of 1,400mph (2253km/h), on 14 December 1959 Jordan also established a 30,000m time-to-climb mark of 5min 4.92 sec, and even surpassed the existing balloon record of 101,516ft (30,942m). (56-0885 was written off after a crash in May 1961.)** Lockheed







**Specification – Lockheed F-104B**

| | |
|---|---|
| Model: | 283-93-03 |
| Type: | Operational trainer/fighter |
| Crew: | Two |
| First Flight: | 16 January 1957 |
| Number built: | 26 (1 service test article/25 production models) |
| Powerplant: | One 9,600lb (4,354kg) static thrust, 14,800lb (6,713kg) afterburning General Electric J79-GE-3A/3B turbojet |
| Dimensions: | Span, without tip tanks, 21ft 9in (6.62m); wing area, 196.1sq ft (18.21m²); length, 54ft 8in (16.66m); height, 13ft 5in (4.08m) |
| Empty weight: | 13,727lb (6,727kg) |
| Combat weight: | 17,812lb (8,080kg) |
| Max take-off weight: | 24,912lb (11,300kg) |
| Performance: | Max speed, 1,145mph (1,843km/h) at 65,000ft (19,812m)<br>Cruising speed, 516mph (830km/h)<br>Climb in one minute, 64,500ft (19,660m)<br>Service ceiling, 64,500ft (19,750m)<br>Range, 460 miles (740km)<br>Maximum range, 1,225 miles (1,971km) |
| Fuel: | Normal, 752 USgal (2,846l)<br>Maximum, 1,482 USgal (5,609l) |
| Armament: | Two machine guns |

aloft in a training programme conducted at Edwards AFB, California (*see* Chapter 8).

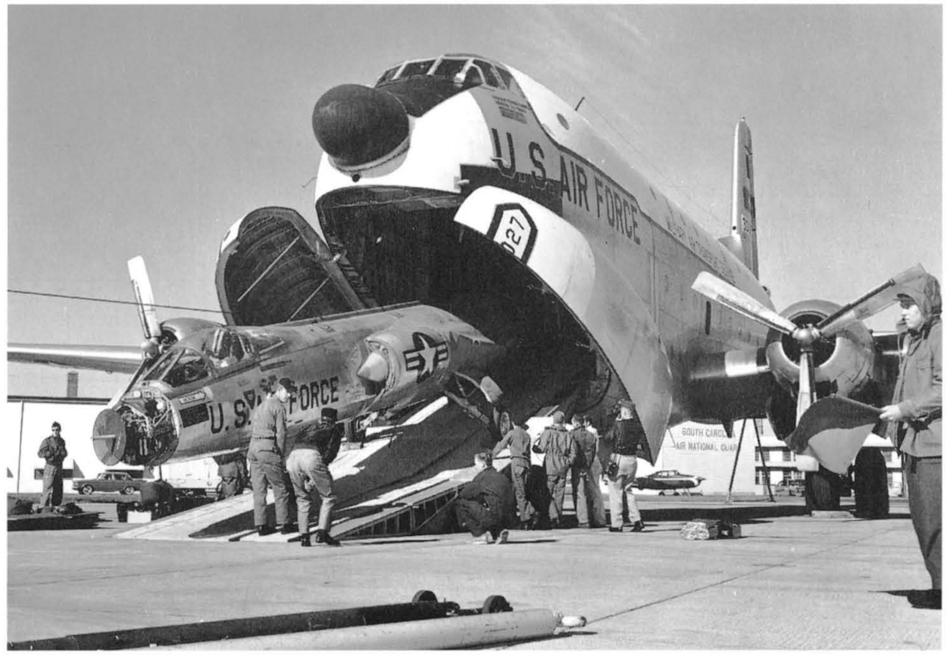
### *Air National Guard Service*

During 1960 the F-104As and F-104Bs were phased out of Air Defense Command to make way for the more heavily armed McDonnell F-104A and -B. Starfighters were transferred to three Air National Guard squadrons, beginning in February 1960 with the 157th FIS, North Carolina ANG, which activated at Congaree Air Base (renamed McEntire ANGB on 10 November 1961 in honour of Brig Gen Barnie B. McEntire, the late commander of the South Carolina ANG, who had been killed on 25 May 1961 when he stayed in his crippled F-104A to avoid crashing in a populated area at Harrisburg, Pennsylvania). The 151st Fighter Interceptor Squadron, Tennessee Air National Guard, activated at McGhee Tyson Airport, Knoxville, in June, and the 197th FIS, Arizona ANG, activated at Skyharbor Airport, Phoenix, in July.

### *The Berlin Crisis*

The Berlin Crisis broke out in summer 1961 and preparation for the mobilization of ANG flying squadrons was still underway when, on 13 August 1961, the Soviets and East Germans began erecting the Berlin Wall. On 1 November all three ANG fighter interceptor squadrons flying F-104As were activated for deployment to Europe. As their range was insufficient for the Atlantic crossing, the F-104As of the ANG were ferried in C-124 Globemasters

*(Above)* Four F-104A-15-LOs – 56-772, 766, 737, and 748 – of Air Defense Command. Forty-nine out of 296 Starfighters operated by the USAF were lost and 18 pilots killed, and in 1960 the type was withdrawn from ADC. Twenty-four were converted to QF-104 target drones, while three were modified to NF-104A models. The remaining F-104As, fitted with the GE-19 engine, returned to first-line service. Lockheed



When the Berlin Crisis broke out in summer 1961 all three ANG fighter-interceptor squadrons flying F-104As were activated for deployment to Europe in Operation *Brass Wing*. As their range was insufficient for the Atlantic crossing, the F-104As were ferried in C-124s. On 24 November 1961 Military Air Transport Service (MATS) loadmasters began loading the first F-104A of the recently recalled South Carolina ANG's 157th Fighter Interceptor Squadron through the loading ramp of a Douglas C-124 Globemaster to be transported to Morón, Spain. USAF

An F-104A of the 313th Fighter Interceptor Squadron ANG at Homestead AFB, Florida, on 19 October 1968. When the Cuban Missile Crisis erupted on 22 October 1962, the ANG F-104As were returned to duty with Aerospace Defense Command where they equipped the 319th FIS at Homestead, and the 331st FIS at Webb AFB, Texas replacing the F-106A and the F-102A respectively. The F-104s were finally phased out when the 319th FIS was deactivated in December 1969. USAF

**Specification – Lockheed F-104C**

| | |
|---|---|
| Model: | 483-04-05 |
| Type: | All-weather fighter/bomber |
| Crew: | Pilot only |
| First Flight: | 16 October 1958 |
| Number built: | 77 |
| Powerplant: | One 10,000lb (4,536kg) static thrust, 15,800lb (7,167kg) afterburning General Electric J79-GE-7 turbojet |
| Dimensions: | Span, without tip tanks, 21ft 9in (6.62m); wing area, 196.1sq ft (18.21m$^{1}$); length, 54ft 8in (16.66m). Height, 13ft 6in (4.11m) |
| Empty weight: | 12,760lb (5,788kg) |
| Gross weight: | 22,410lb (10,165kg) |
| Combat weight: | 19,470lb (8,832kg) |
| Max take-off weight: | 28.853lb (12,634kg) |
| Performance: | Max speed, 1,150mph (1,851km/h) at 50,000ft (15,240m)<br>Cruising speed, 510mph (821km/h)<br>Climb in one minute, 54,000ft (16,459m)<br>Service ceiling, 58,000ft (17,678m)<br>Combat ceiling, 58,000ft (17,680m)<br>Range, 850 miles (1,368km)<br>Maximum range, 1,500 miles (2,414km) |
| Fuel: | Normal, 897 USgal (3,395l)<br>Maximum, 1,627 USgal (6,158l) |
| Armament: | One 20mm M-61 Vulcan rotary cannon, two machine guns, 2,00lb (907kg) bombs |

of the Military Air Transport Service (MATS) during Operation *Brass Wing*. The 157th FIS remained at its home base in South Carolina for the first three weeks of November before relocating to Morón Air Base in Spain on the 24th. The 151st and 197th Fighter Interceptor Squadrons were based at Ramstein Air Base, West Germany. The 151st assumed alert duty at Ramstein on 19 December.

When these three ANG squadrons returned to the USA in August 1962 they once again came under the control of their respective states, although the 197th FIS F-104A/Bs were retained by the US Air Force (in September 1962 the 197th FIS re-equipped with the Boeing C-97G and it was re-designated the 197th ATS and became MATS-gained).

### *Cuban Missile Crisis*

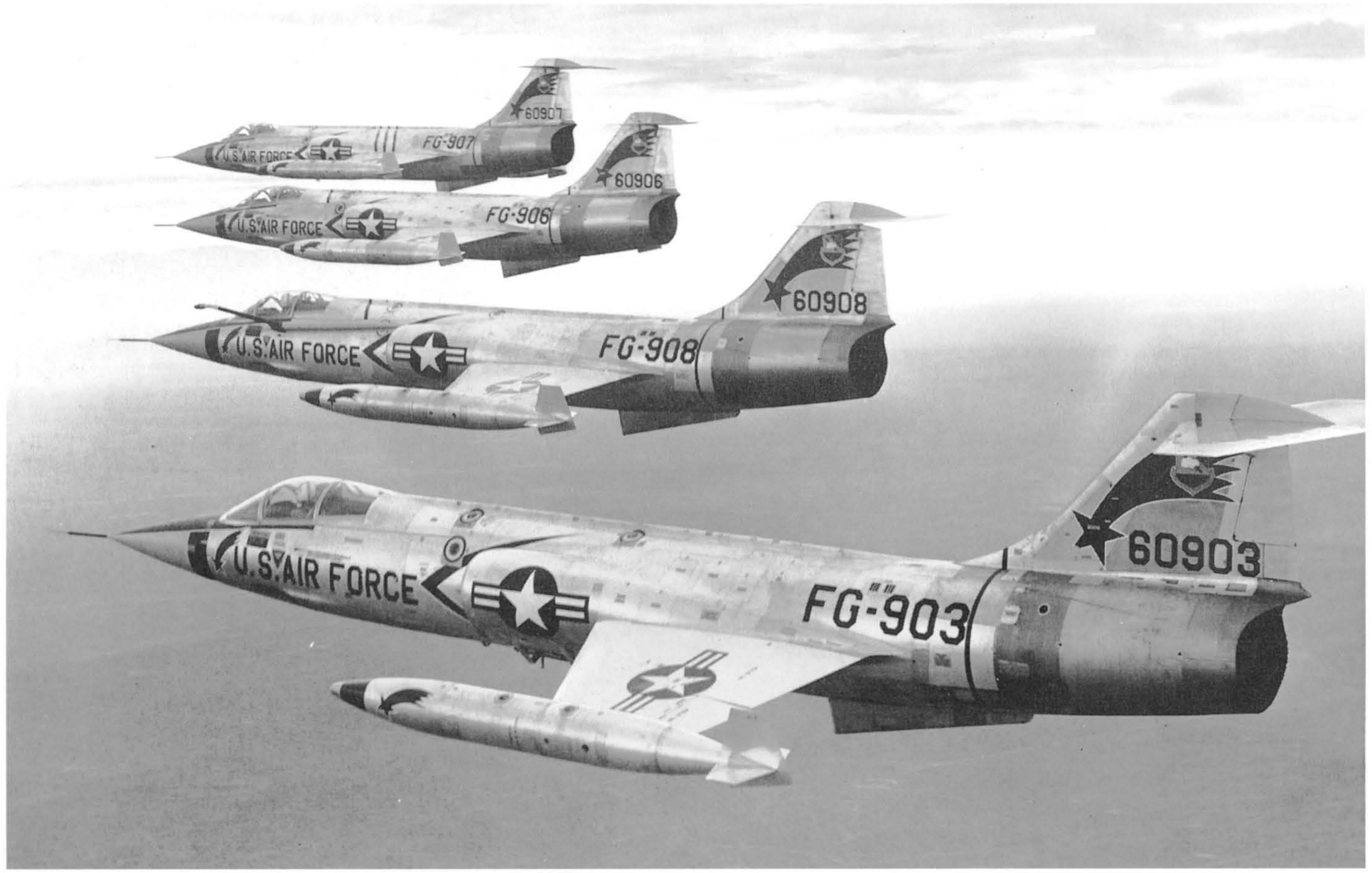
When the Cuban Missile Crisis erupted on 22 October 1962, the ANG F-104s were returned to duty with Aerospace Defense Command where they equipped the 319th FIS at Homestead AFB, Florida, and the 331st FIS at Webb AFB, Texas, replacing the F-106A and the F-102A respectively. The 151st FIS ANG gave up its Starfighters in March 1963 when it converted to the Convair F/TF-102A, and the 157th FIS ANG relinquished its Starfighters in June 1963 when it re-equipped with the F-102 also. The 331st FIS deployed to Puerto Rico during the Dominican Republic Crisis of May 1965. The F-104s were finally phased out when the 319th FIS was deactivated in December 1969. After this, serviceable F-104As and F-104Bs went to Taiwan and Jordan and all non-serviceable aircraft went into storage at the Aerospace Maintenance and Regeneration Center (AMARC) at Davis-Monthan AFB, Arizona.

### *F-104C/D Enter Service with Tactical Air Command – Briefly*

Some seventy-seven examples of the F-104C fighter-bomber variant, which first flew on 24 July 1958, were built for Tactical Air Command. The 'C' was powered by a J79-GE-7A, whose turbine had a 2in increase in diameter, providing 15,800lb (7,167kg) of thrust. It also introduced a probe for in-flight refuelling and was the first Starfighter to have operative flap-blowing from the outset. It could carry two 170-gal tanks or two 1,000lb (454kg) bombs, a Mk 28 nuclear weapon, or four Sidewinder missiles. The 476th Tactical Fighter Squadron (TFS) of the 479th Tactical Fighter Wing (TFW) at George AFB, California, was the first to receive the F-104C, beginning in September 1958. Subsequently, the three other squadrons in the 479th – the 434th, 435th and 436th – were also equipped. (The 'C' was joined on the Burbank production lines by twenty-one tandem-seat F-104D models, which, like the F-104C, was powered by a 15,800lb (7,167kg) J79-GE-7 and were fitted with blow flaps and in-flight probe-and-drogue refuelling equipment. They could also operate in the ground-attack role. The F-104D Starfighters were accepted by Tactical Air command during 1958–59.)

In November 1959 the 479th TFW made an overseas deployment to Morón Air Base, Spain, where one squadron remained on a rotational basis until 1963. During the 1960 Berlin Crisis the Morón-based squadron of F-104Cs transferred to Bitburg air Base, West Germany, while the other three squadrons at George AFB, deployed to Hahn and Ramstein Air Bases in West Germany.

By early 1962 all except the Morón-based squadron were back at George AFB and then, when the Cuban Missile Crisis broke out in October 1962, all of the F-104Cs at George were redeployed to Key West, Florida. In 1963 a number of F-104Cs of the 479th TFW were employed in operational testing and in November a detachment was sent to the Arctic as part of Project *Diamond Lil*. (A second Arctic deployment was made by the 479th TFW in 1965.)



**(Above)** **Four F-104C-5-LOs – 56-60903, 60908, 60906 and 60905 – of the 479th TFW, Tactical Air Command, on a training mission from George AFB. All of these Cs were lost. FG-0907 was lost in January 1959, FG-0906 was lost in June 1960, 56-908, which is fitted with a removable in-flight refuelling probe, was lost at Da Nang, South Vietnam in July 1965 while assigned to the 436th TFS, and FG-0903 was lost in July 1966.** Lockheed

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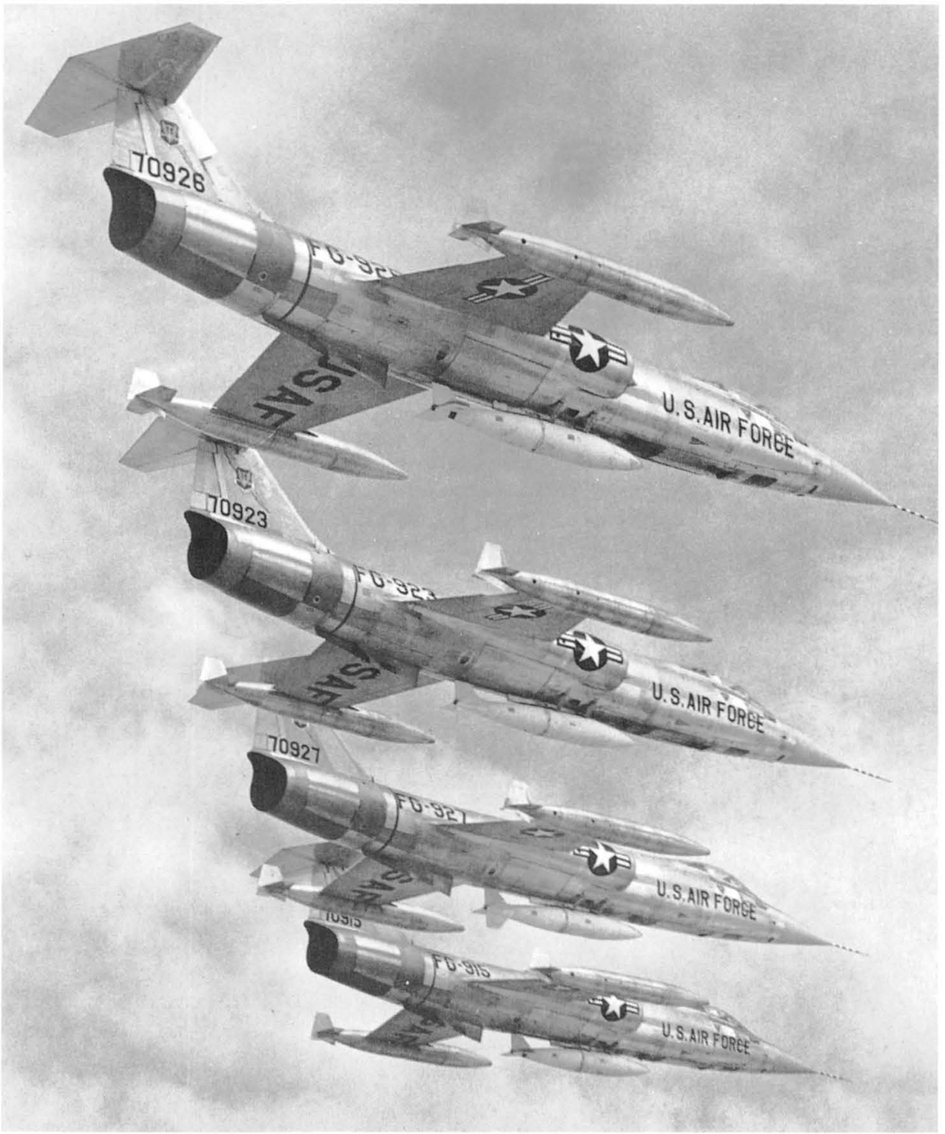
THE STARFIGHTERS 'U'

**The same Starfighters, used to publicize a movie of the time called (what else?) 'The Starfighters'!** via Philip Jarrett

## *'C' Succeeds at William Tell 1962*

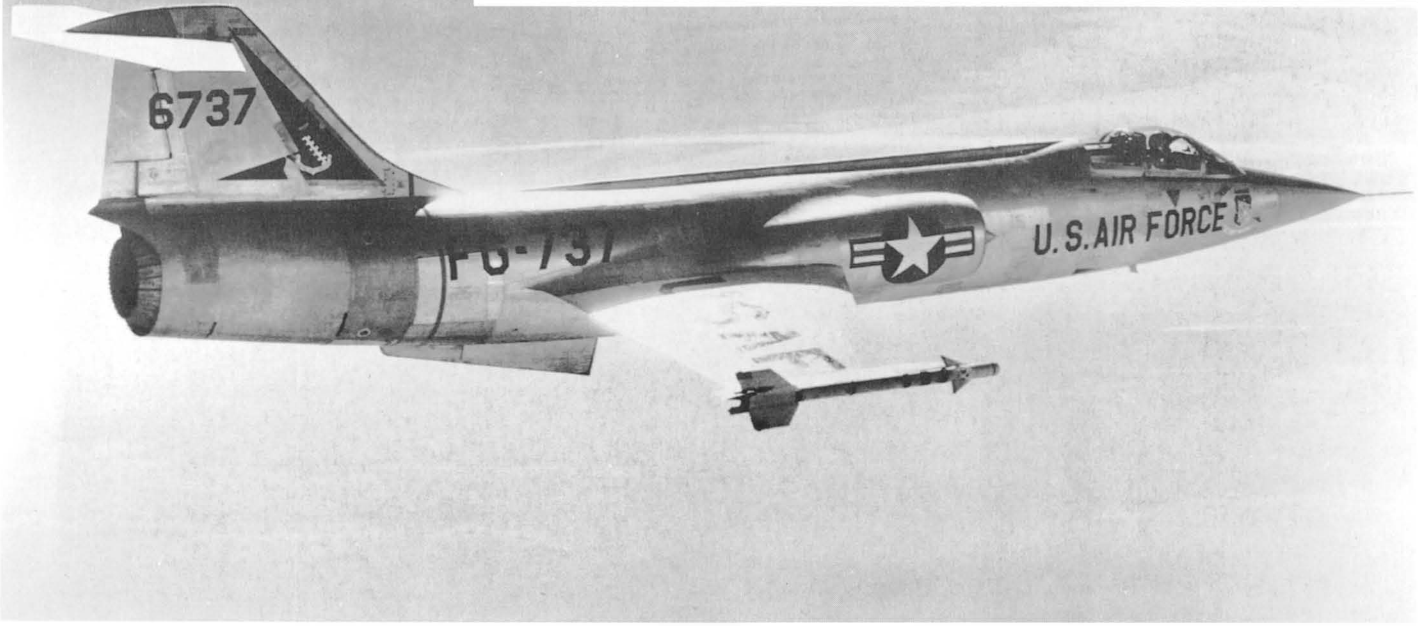
In September 1962, at the 'William Tell 1962' Fighter Weapons Meet, held biennially at Nellis AFB near Las Vegas, a single F-104C, flown by Captain Charles E. Tofferi, a 29-year-old pilot representing the 479th Tactical Fighter Wing from George AFB, took on ten North American F-100 Super Sabres and three Republic F-105 Thunderchiefs. Lockheed's publicity machine proudly reported that:

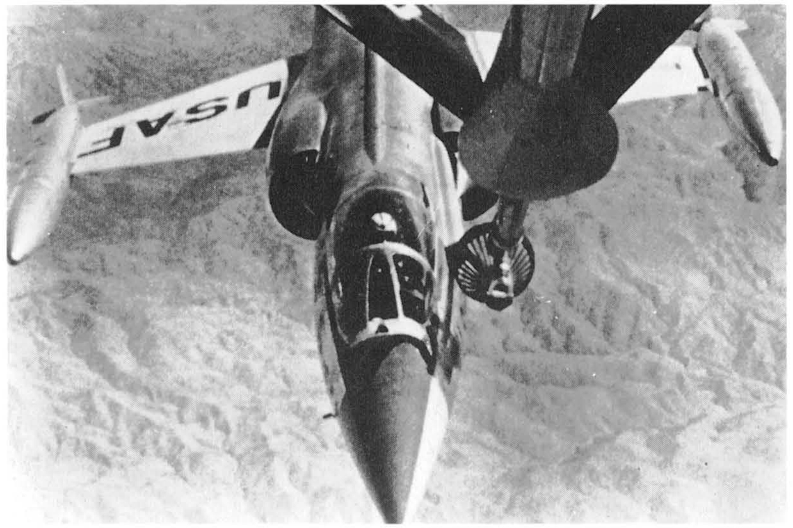
> The loner generally was regarded as an interloper in the four-day competition, since the 479th was equipped and trained more for nuclear weapons delivery and the contest included several categories in conventional weapons.
>
> Captain Tofferi and his F-104C were unstoppable. At meet's end, he had outscored all other pilots – top marksmen from top TAC units around the world – to post a remarkable victory. He scored 19,018 points out of 24,000 possible. His nearest competitor had 17,304 points. Three of his close-support missions were scored as perfect 1,000s. Downing a towed dart target with his Vulcan 20mm cannon in just 63 seconds he set a new record and picked up the maximum 3,000 points for that division. Among the Starfighter's features, he gave particular credit to its short turning radius (with manoeuvring flaps) and tremendous acceleration for his championship showing.



**Four F-104C-10-LOs – 57-0926, 0923, 0927 and 0915 – of the 479th TFW, Tactical Air Command, with 170gal wingtip, and 225-gal fuselage tanks. 57-0927 was among the first aircraft to carry fuselage-mounted missile rails for a pair of AIM-9 Sidewinder air-to-air missiles and was involved in the early trials.** Lockheed

**(Below)** **F-104A-5-LO 56-0737 of the 479th TFW, Tactical Air Command with two wingtip-mounted AIM-9 Sidewinders. The missiles provided a degree of lateral stability, with no reduction in G limits, and also created lift.** Lockheed

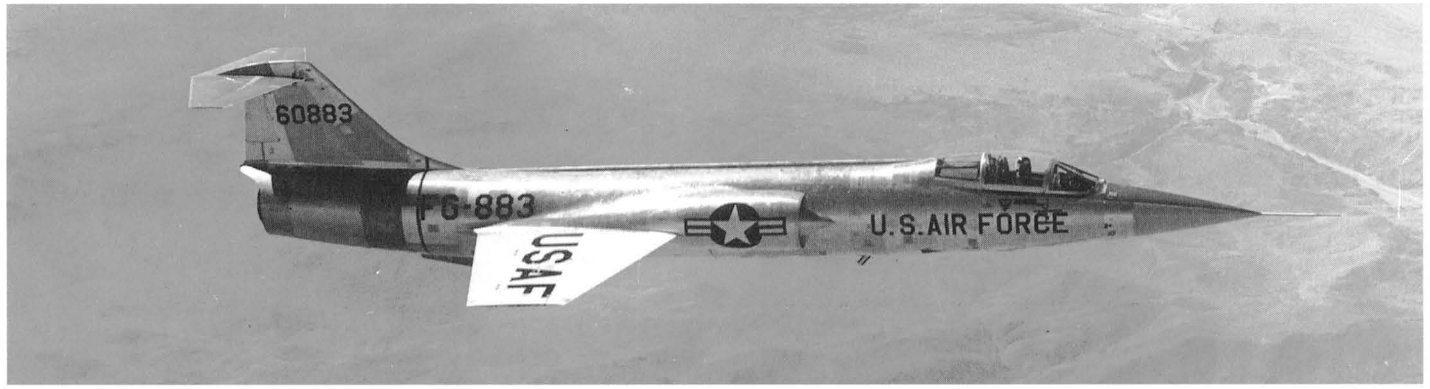


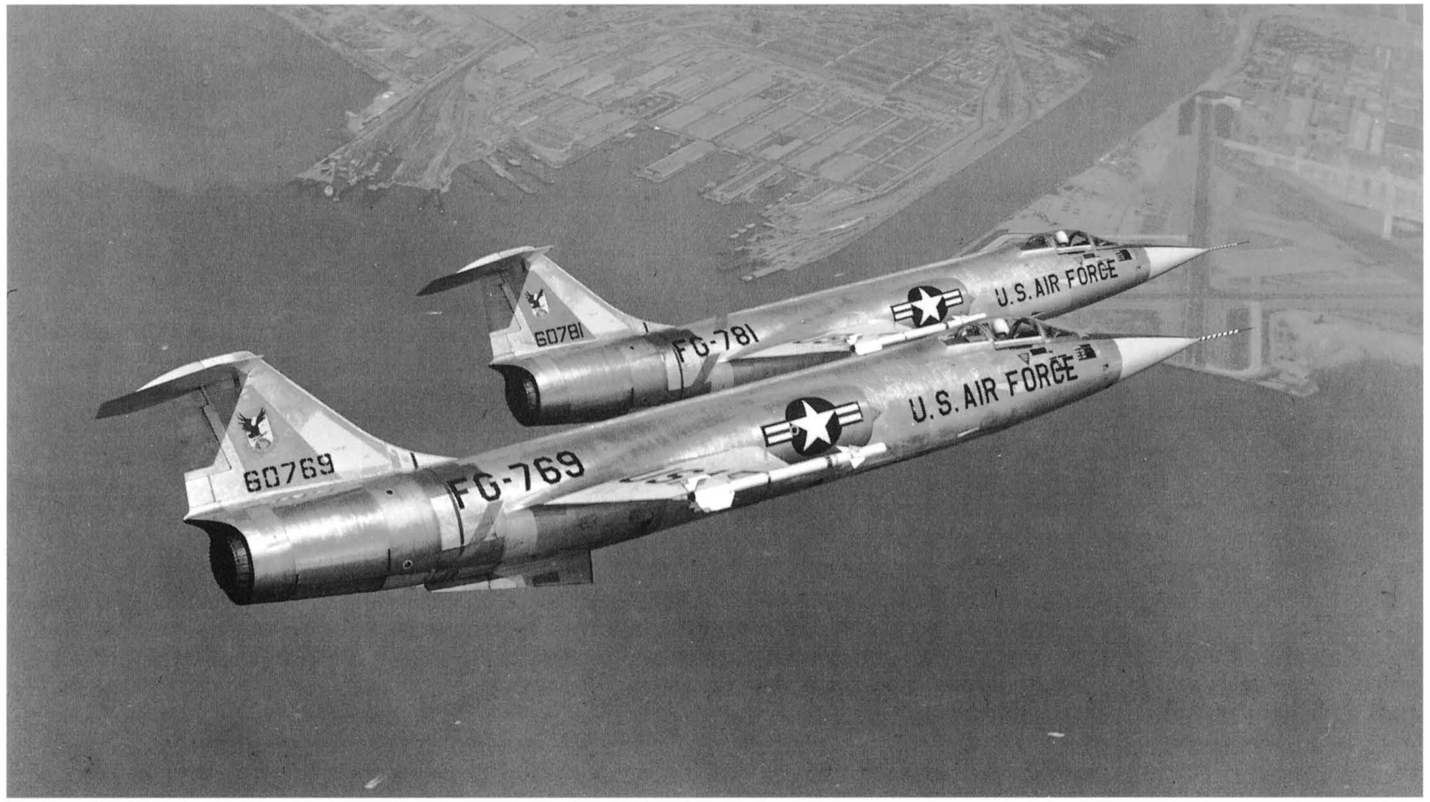


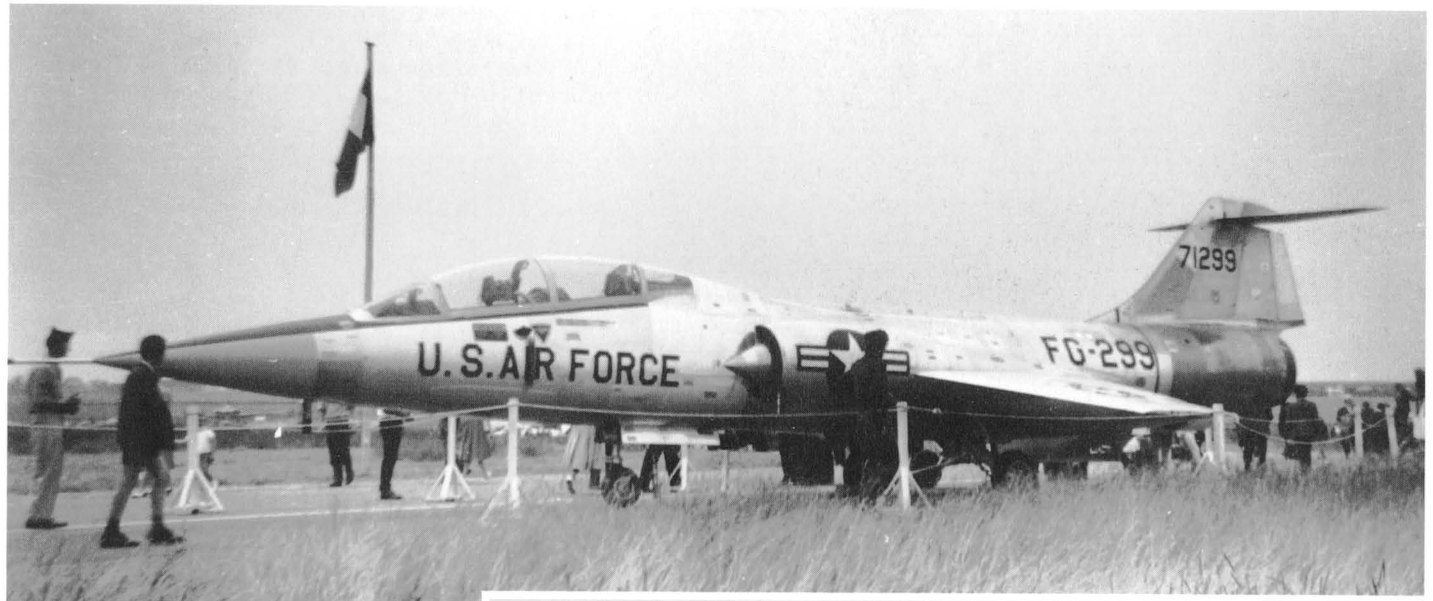
**F-104C Starfighter pulling in to refuel from the 'flying-boom' of a KC-135A airborne tanker. The boom extends from a stowed length of 28ft (8.5m) to a maximum of 47ft (14.3m) and provides for a maximum transfer rate of almost 1,000 USgal per minute.** via Philip Jarrett

***(Below)*** **F-104C-5-LO 56-083 in flight. The F-104C, powered by a J79-GE-7A, first flew in July 1958, and seventy-seven of these fighter-bombers were built for Tactical Air Command. In this role they could carry two 170-gal tanks or two 1,000lb (453.6kg) bombs, a Mk 28 nuclear weapon beneath the fuselage, or four GAR-8 Sidewinder missiles. Deliveries to the 831st Air Division began on 16 October 1958 at George AFB.** Lockheed

***(Bottom)*** **F-104A-20-LO 56-0769 and 56-0781 of the 83rd Fighter Interceptor Squadron from Hamilton AFB, San Francisco, California, in formation over the Golden Gate bridge.** Lockheed



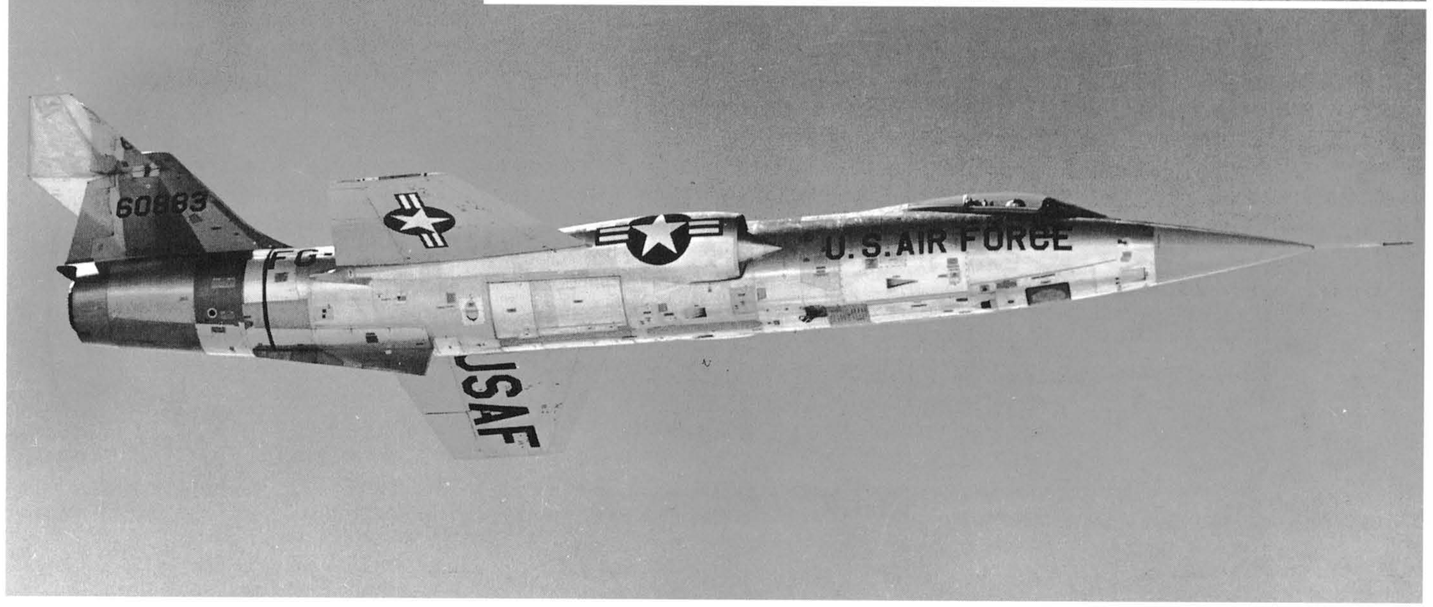




***(Above)*** **F-104B-5-LO at Versailles, France. Twenty-six tandem-seat F-104Bs were built, the first flying on 7 February 1957.** via *Aeroplane*

***(Right)*** **The public came to admire the F-104 Starfighter, in this case, F-104B-10-LO 57-1307.** via Philip Jarrett

**F-104C-5-LO 56-0883 without wingtip tanks, in flight.** Lockheed



### *F-104Cs in Action in SE Asia*

In April 1965, twenty-five F-104Cs of the 436th Tactical Fighter Squadron (TFS), 479th Tactical Fighter Wing (TFW), were sent to Da Nang Air Base in South Vietnam to fly MiG combat air patrol (MiGCAP) missions. Detachments were also sent to Kung Kuan, Taiwan. To protect strike aircraft from the MiGs of the NVNAF, the F-104Cs were armed with their single M61A1 20mm Vulcan cannon and four AIM-9 Sidewinder air-to-air missiles.

**F-104C-5-LO 56-922 over the battle zone during Exercise** Desert Strike, **a joint US Army/USAF Strike Command exercise carried out during 5–29 May 1964 on and over 9,600 miles (15,450km) of the Mojave Desert, California.** USAF via Robert F. Dorr

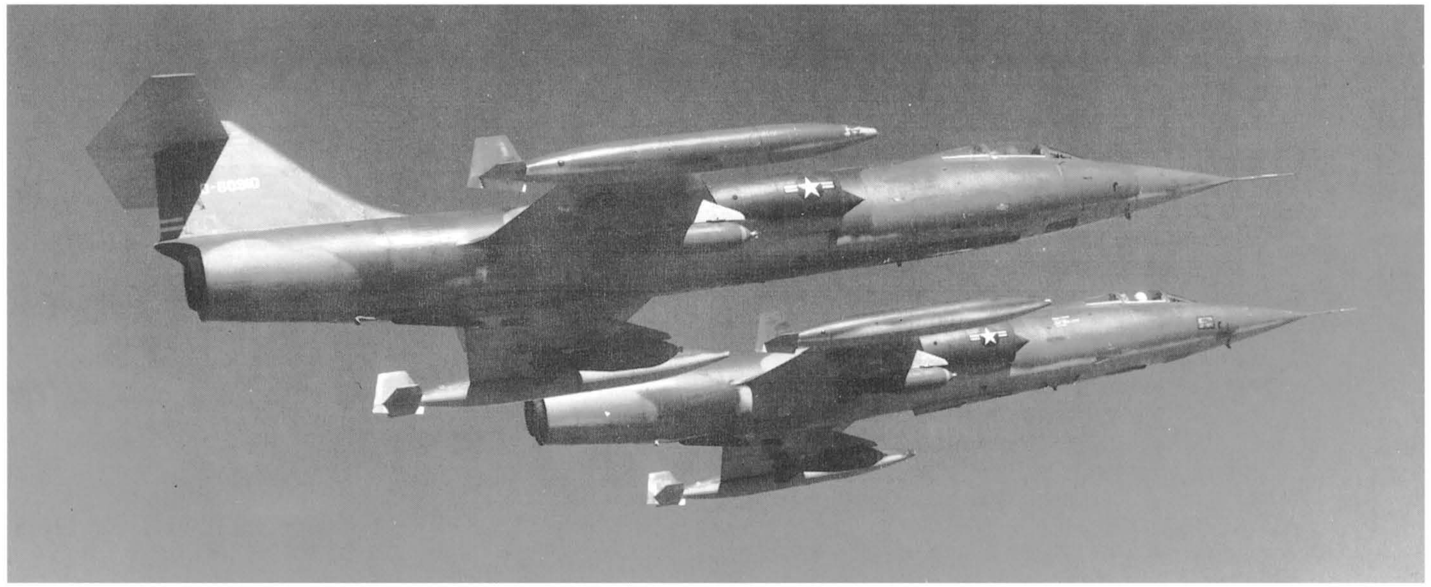
**F-104C 56-0892 of the 476th Tactical Fighter Squadron, 479th TFW at Tan Son Nhut AB, Vietnam in 1965. Starfighters carried too small a warload and even with in-flight refuelling, had insufficient range for the majority of missions in SE Asia. In November 1965 this first detachment of Starfighters in SE Asia returned to the United States.** USAF

On the night of 20 September 1965 Maj Philip E. Smith tried to relieve another F-104C pilot who had been flying MiGCAP on station over the Gulf of Tonkin in bad weather. Smith's navigation system failed, and he was forced to seek lower altitude in an effort to establish his position. Instead, Smith was intercepted by two People's Republic of China F-6 (MiG-19) fighters. One of these, piloted by Gao Xiang, destroyed the Starfighter at low altitude over Hainan Island with cannon fire.

Two more F-104Cs of the 436th TFS, meanwhile, who were flying RESCAP (Rescue combat air patrol) this night, had tried unsuccessfully for two hours to find Major Smith. Returning to Da Nang they had a mid-air collision and both pilots were killed. Smith meanwhile, had ejected safely but had been captured and taken prisoner, the only F-104 pilot to hold this unenviable distinction in the war in SE Asia. (Smith was held in China until his release in 1973). A week after the loss of the three F-104Cs, a fourth Starfighter was lost in Vietnam when it was shot down by anti-aircraft fire.

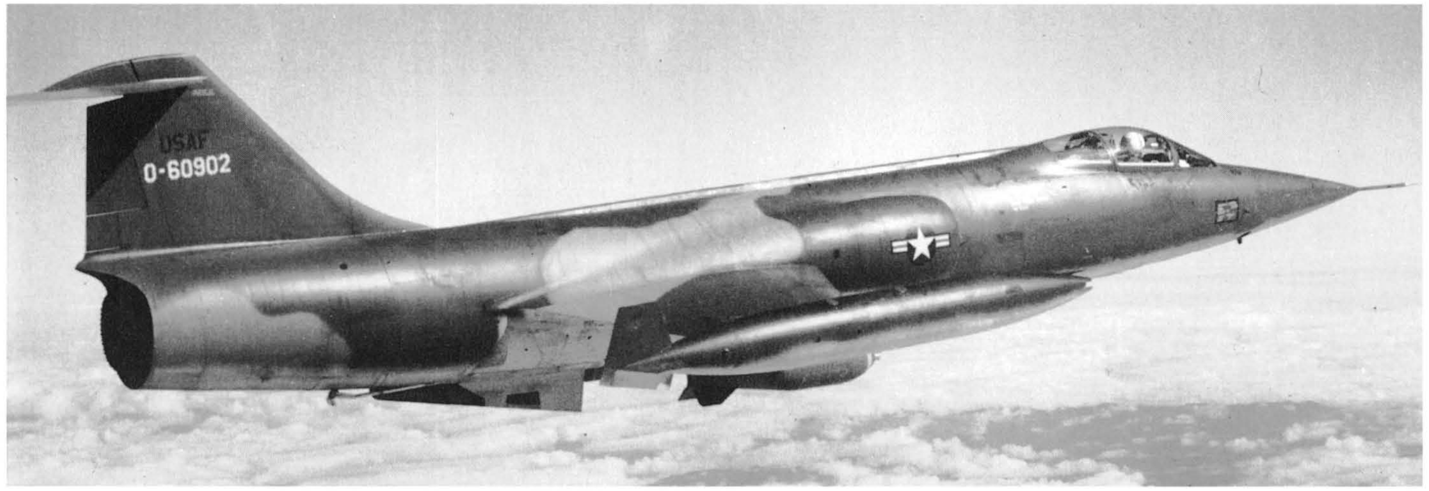
The F-104Cs (and Northrop F-5As) were too short-ranged and carried an insufficient weapons load for this kind of operation and consequently, the McDonnell F-4C Phantom II took over the MiGCAP mission. In November 1965 the remaining F-104Cs of the 436th TFS were rotated back to George AFB, California. In Vietnam the Starfighter had flown some 506 combat sorties, totalling 1,706.9 combat hours, with the loss of four F-104Cs.

Beginning in May 1966 the first F-104Cs of the 479th TFW were sent to SE Asia, to be based at Udorn Royal Thai Air Force Base (RTAFB) in Thailand under the control of the 8th TFW. This time the F-104Cs, which by now were camouflaged, flew low-level, close-support strikes against North Vietnamese lines of communication. By June 1967 all four squadrons were in action but the Starfighter's short range, even with in-flight refuelling, was insufficient for the majority of missions in SE Asia, and in July the 479th TFW was rotated back to George AFB for the last time, to be replaced by the McDonnell F-4D Phantom.

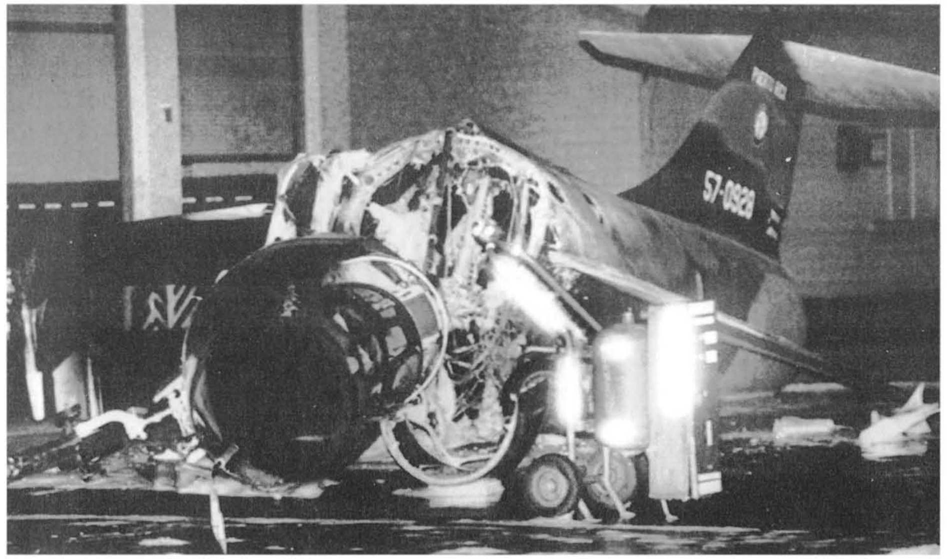


**Two F-104Cs of the 479th TFW assigned to the 8th TFW at Udorn armed with 750lb (340kg) M117 bombs en route to their target in Vietnam, in November 1966. This second deployment to SE Asia was made in June 1966, and the mission was largely MiGCAP. Eight Starfighters were lost in action in SE Asia and another six were destroyed in operational accidents for little return and both the F-104C and -D were soon phased out of theatre. 56-0910 was transferred to the Puerto Rican ANG after use in SE Asia, and finally to Lowry AFB for display.** USAF

**F-104Cs of the 479th TFW at Udorn AB, Thailand. During their tour of duty in SE Asia, the 479th TFW's Starfighters logged 2,269 combat sorties for a total of 8,820 combat hours.** USAF



**F-104C-5-LO 56-0902 of the 436th TFS, 479th TFW, assigned to the 8th TFW at Udorn heads for its target in South Vietnam armed with two 750lb (340kg) M117 bombs. In the summer of 1967 this Starfighter, and the other surviving F-104C/Ds in the USAF inventory were transferred to the 198th TFS, 156th TFG, of the Puerto Rico Air National Guard (PRANG!) where they replaced the F-86H.** via Robert F. Dorr



**The wrecked remains of F-104C-10-LO of the 198th TFS, 156th TFG Puerto Rico ANG, one of nine aircraft destroyed at Muniz ANG base adjacent to San Juan's international airport following attacks by saboteurs with bombs. The Puerto Rico ANG operated Starfighters until its conversion to the LTV A-7D Corsair in the summer of 1975 and the last Starfighter in USAF service was retired on 31 July 1975.** AP

In thirteen months the F-104Cs had flown a total of 2,269 combat sorties, totalling 8,820 combat hours. Losses now totalled eight Starfighters missing in action (two to Soviet-built SA-2 surface-to-air (SAM) missiles and six to AAA) and another six were destroyed in operational accidents. In the summer of 1967 the surviving F-104C/Ds in the USAF inventory were transferred to the 198th TFS of the Puerto Rico Air National Guard where they replaced the F-86H. This unit operated Starfighters until its conversion to the LTV A-7D Corsair in the summer of 1975 and the last Starfighter in USAF service was phased out of operational service in 1975, although they continued to be used in a training role until 1983.

The Starfighter's short and uninspired career seemed to be over, and in the USA it was, but Lockheed, desperate for success, pursued more lucrative markets in Europe and beyond.

**USAF Starfighter Units 1964–83**

479th Tactical Fighter Wing (TFW) George AFB, Ca.

- 434th TFS
- 436th TFS
- 435th TFS
- 476th TFS

Air Defense Command, Tyndall AFB, Florida

Aerospace Research Pilots School, Edwards AFB, Ca.

4510 Combat Crew Training Wing: 1964–69

- 4512 CCT Squadron
- 4518 CCT Squadron
- 4443 CCT Squadron

58th Tactical Fighter Training Wing: 1970–83

- 69th TFTS/418th TFTS
- 83rd Fighter Interceptor Squadron Hamilton AFB, Ca.

319th Fighter Interceptor Squadron, Florida

56th Fighter Interceptor Squadron Wright-Patterson AFB, Ohio

331st Fighter Interceptor Squadron Homestead AFB, Florida

337th Fighter Interceptor Squadron Westover AFB, Massachusetts

538th Fighter Interceptor Squadron Larson AFB, Washington

198th TFS Puerto Rico ANG

151st Fighter Interceptor Squadron Tennessee ANG

157th Fighter Interceptor Squadron North Carolina ANG

197th Fighter Interceptor Squadron Arizona ANG

3205th Drone Squadron, Eglin AFB, Florida

CHAPTER THREE

# G for Germany

*The Starfighter was forever jealous of the pilot's full attention. It rewarded discipline with deeds of airmanship; it could punish the dilatory or those who gave themselves to distractions. It was a marvel in capable hands, and merciless to the careless*

Lt Gen Johannes Steinhoff, Inspector of the *Luftwaffe*[11]

## The Contenders

In December 1957 Oberstleutnant Werner and Maj Walter Krupinski were among the German representatives to arrive in the United States to test fly both the Grumman F11F-1F and the F-104 Starfighter. Krupinski, a mentor of Erich Hartmann, had ended the Second World War as a top scoring *Luftwaffe* fighter pilot with 197 victories, 177 of them in the east. Generally, he was known as 'Graf Punski' owing to his propensity for living life to the full. Krupinski would have been an outstanding character in any air force. In the air he was a bar-room brawler type of flyer with a habit

***(Above)* F-104G-LO 63-13237 built by Lockheed for the** Luftwaffe. **Lockheed built the first F-104Gs and TF-104Gs for the** Luftwaffe. **Thereafter, F-104G production was carried out in Europe. The F-104G-LO (Model 683-10-19) was by far the most important Starfighter version and resulted from a competition, won by Lockheed in October 1958 against eight other aircraft types, to supply the** Luftwaffe **with multi-role, all-weather, aircraft. West Germany received 916 Starfighters, including 262 F-104F-LO, TF-104G-LO and F-104G-LO models from Lockheed. F-104Gs were used to train** Luftwaffe **pilots in Arizona. Before the F-104G export models were ready for operational use by the** Luftwaffe, **American instructors trained German F-104 personnel at Luke AFB, Arizona, using some Gs and thirty F-104F two-seat trainers (identical to the F-104D) for flight-training.** Lockheed

**F-104 DA+101 (KF101), the first F-104G Starfighter built for the** Luftwaffe, **which first flew on 5 October 1960 in the hands of Charles A. Kitchens, at Palmdale, California. DA+101 was used by the Joint Test Force Team to test fire control, armament and electronics systems. It was issued to** JaboG31 **(as KE+101) in 1962 and finally stored at** LwSchleuse 11 **on 2 May 1983 before going to Turkey, where it was phased out in 1989 and scrapped.** USAF

**Specification – Lockheed F-104G**

| | |
|---|---|
| Model: | 683-10-19 |
| Manufacturers: | Lockheed Aircraft Corporation, Burbank, California. Canadair: ARGE (*Arbeitsgemeinschaft*)-Süd (or Work Group South); Messerschmitt, Heinkel, Dornier and Siebel. MBB (Messerschmitt-Bolkow-Blohm). ARGE Nord (Work Group North) Fokker, Aviolanda, Hamburger Flugzeugbau (HFB), Weserflugzeugbau, Focke-Wulf. West Group: Avions Fairey S.A. and SABCA (*Société Anonyme de Constructions Aéronautiques*). Fiat, Aerter, Macchi, SIAI-Marchetti, Piaggio and SACA |
| Type: | Multi-role, all-weather fighter |
| Crew: | Pilot only |
| First Flight: | 7 June 1960 |
| Number built: | 1,122 (139 by Lockheed, 140 by Canadair, 164 by Fiat, 231 by Fokker, 50 by MBB, 210 by Messerschmitt, 188 by SABCA) |
| Powerplant: | One 10,000lb (4,536kg) static thrust, 15,600lb (7,076kg) afterburning General Electric J79-GE-11A turbojet |
| Dimensions: | Span, without tip tanks, 21ft 9in (6.62m); wing area, 196.1 sq ft (18.21m²); length, 54ft 8in (16.66m); height, 13ft 5in (4.08m) |
| Empty weight: | 13,996lb (6,348kg) |
| Combat weight: | 20,640lb (9,362kg) |
| Max take-off weight: | 29,038lb (13,172kg) |
| Performance: | Max speed, 1,146mph (1,844km/h) at 50,000ft (15,240m), 1,328mph (2,137km/h) at 35,000ft (10,668m)<br>Cruising speed, 510mph (821km/h)<br>Climb in one minute, 48,000ft (14,630m)<br>Service ceiling, 50,000ft (15,240m)<br>Absolute ceiling, 90,000ft (27,432m)<br>Range, 1,080 miles (1,738km)<br>Maximum range, 1,630 miles (2,623km) |
| Fuel: | Normal, 897 USgal (3,395l)<br>Maximum, 1,784 USgal (6,617l) |
| Armament: | One 20mm M-61 Vulcan rotary cannon, four AAM missiles, 4,000lb (1,814kg) bombs |

**F-104G DA+109 (63-13247) which was issued to** JaboG31 **on 22 May 1962. On 25 June 1969 this aircraft (later coded 20+45) was returned to MBB for maintenance then brought up to training aircraft standard. DA+109 is now displayed at Museum Gunter Leonhardt, Hannover-Laatzen.** USAF

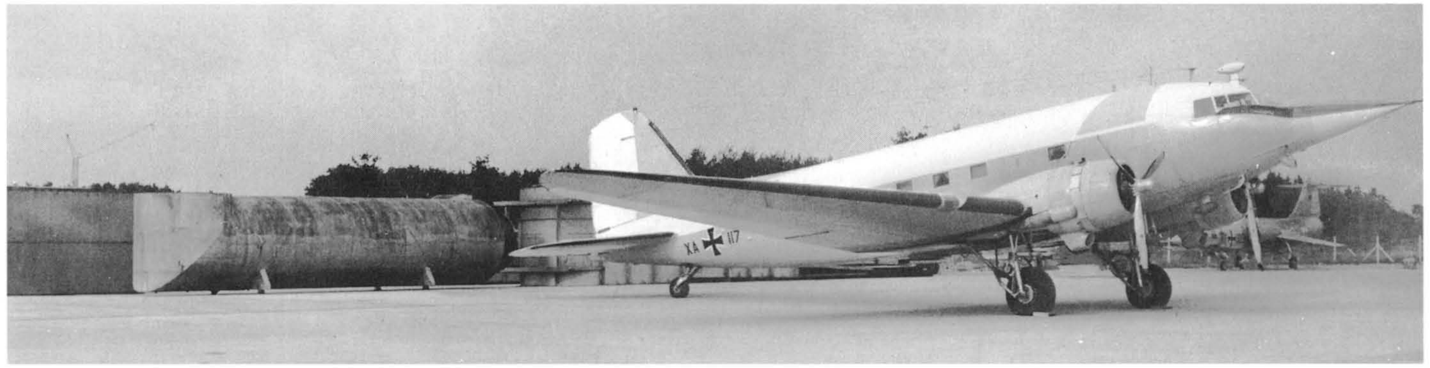
of getting himself into impossible situations which he somehow survived.[12]

The fact that the Grumman design, and the French contender, the Dassault Mirage, were still in the prototype stage while the F-104 was about to be introduced into USAF service, probably helped to speed up the German decision-making process when it came to selecting the winning fighter design.

Although the Mirage was thought to be superior in dogfights, it could not outweigh the Starfighter's overall superior performance. Although both the F-104A and B, as demonstrated, did not deliver the all-weather capability nor the weapon load requirements West Germany expected, Lockheed suggested that an improved version – the F-104G 'Super Starfighter' – would have the necessary structural improvements and radar and flight navigation systems installed that would make it suitable for *all* West Germany's needs.

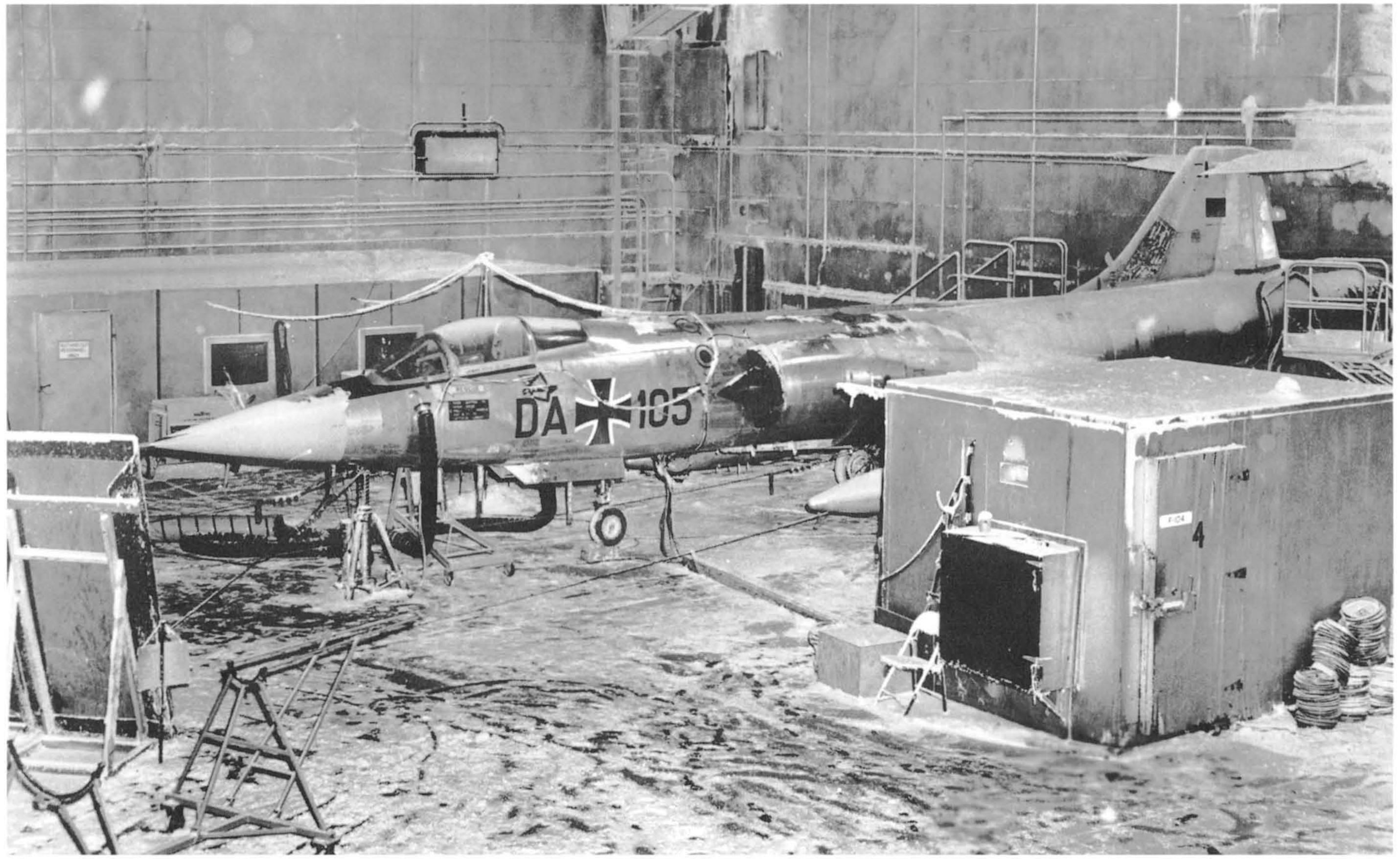
As has already been explained, in 1959 Lockheed won the contract to supply West Germany with the Starfighter and the company would build the first F-104Gs and TF-104Gs for the *Luftwaffe*. Thereafter, F-104G production would be carried out in Europe.

The export models represented a quantum leap in avionics over the A and C models. All of the avionics were packaged in containers referred to as 'gas cans' due to their appearance. All of these gas cans were in turn installed in the avionics bay in a 'tee rack' so-called because of its shape, an inverted T. All avionics interface wiring, cooling air ducting and installation hardware were included in the tee rack. The entire installation was quite compact and efficient. Avionics systems packed in this manner included the MH-97 Autopilot, M-2 Bombing Computer, F-15A North American Search and Ranging radar (NASARR), Multi-mode Radar System electronics, LN-3 Inertial Navigation System, ARC-552 UHF Receiver/Transmitter, AN/ARN-52 TACAN Receiver/Transmitter, and AN-APX-46 IFF Transponder. Also installed in the avionics bay were the Position Homing Indicator (PHI) System, the C-2G Directional Gyro/Compass System, various models of Emergency UHF radios, and components of the Infra-red and Optical Sight Systems. None of these systems were installed in the F-104A and C models except for the sights.[13]



**The Lockheed company-owned F-104 needle nose DC-3 N18565, pictured in March 1963. The normal transport seats were removed and inside the cabin were F-104G electronic gear and major F-104G cockpit components, test and measuring equipment and stations for engineers' monitoring systems. Using this aircraft Lockheed made fifty flights in a 16-week proving programme, which besides checking operation of avionics, evaluated qualities of the F-104's filament-wound, plastic radome. After development use, the unusual DC-3 hybrids saw operational use with the** Luftwaffe **in Germany.** Lockheed

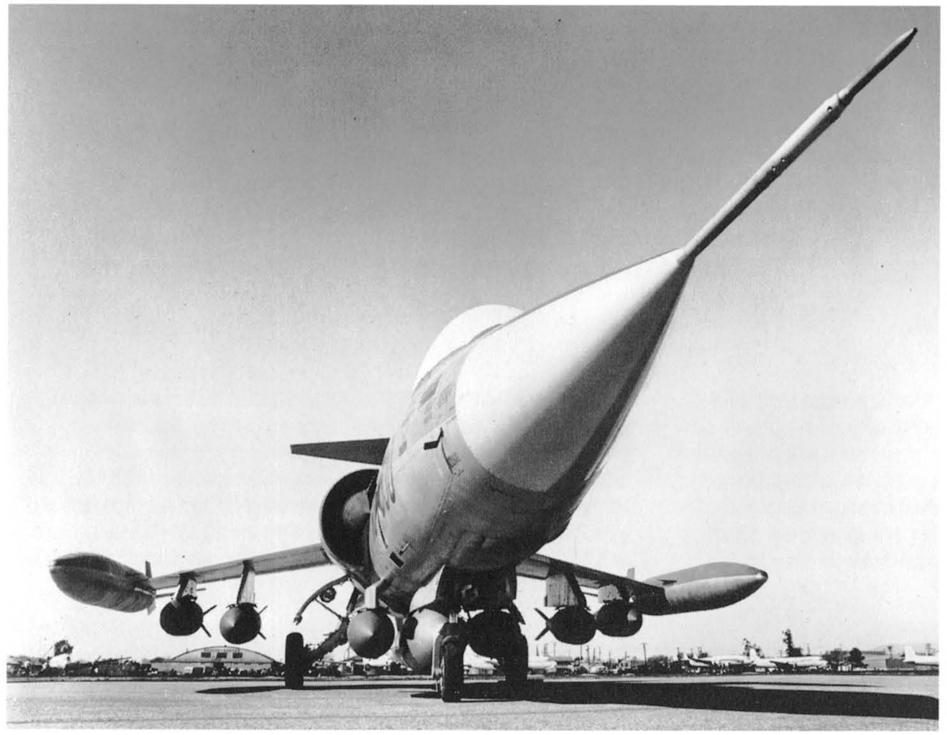
*(Below)* **F-104G-LO DA+105 (683-2027/63-13244) for Germany which received cold weather treatment at Cold Lake CFB, Canada in December 1961. Two months of tests proved the serviceability of the Starfighter's systems at temperatures ranging from plus 120° to minus 65° Fahrenheit. The climatic hangar also duplicated rain and humidity conditions found virtually anywhere in the world. DA+105 went on to serve with the** Erprobungsstelle 61 **(test unit) and never served with an operational unit.** Lockheed



## *Training Begins*

Before the Starfighter export models were ready for operational use the *Luftwaffe* needed a cadre of instructors, and later pilots and ground crews, so at the outset American instructors trained German F-104 personnel at Luke AFB, Arizona, using thirty F-104F two-seat trainers (identical to the F-104D) for flight-training.

Early in 1960 German pilot training began with Lockheed's 'Conversion flight F-104F' course at Palmdale. The German pilots on this first course were led by



**F-104G KG+330 (67-22517) was built by** ARGE-Nord **and assembled by Fokker and first flew on 16 March 1964 at Schiphol before being disassembled and airlifted to Burbank, California. It was planned to use it to test Sideways Looking Airborne Radar (SLAR) but this never materialized. It was modified at Lockheed-Palmdale (seen here armed with conventional bombs on six pylons, and a nuclear store on the aircraft centreline fuselage station) and issued to the USAF. It flew in Arizona with the 4510 CCTW at Luke AFB to train German pilots. All through their long operational career during the Cold War,** Luftwaffe **Starfighters were poised on the borders with the Communist east for a 'Red Alert', and a point-to-point, high-speed, low-level delivery of a live nuclear weapon. To eliminate nuclear flash blindness, German pilots wore a helmet with two visors, one of which darkened in very bright light. This visor tended to react slowly and would not protect the pilot in time. Wolfgang Czaia recalled:**

> **So, we were actually issued eye patches just like 'Pirates of the Caribbean' going off to nuclear missions! The idea was that you took off wearing one eye patch and, in the event of flash, you'd simply remove it and fly with your one good eye! Depth perception would be a problem flying with one eye, and what about the next flash? We knew there was absolutely no way to come back from such a mission.**

**(After 1983 KG+330 was acquired by the RoCAF as 4400.)** Lockheed via Philip Jarrett

***(Left)* F-104G DA+243 of** JaboG31 **'Boelcke' taxiing in with its drag chute deployed.** via Philip Jarrett

Oberstleutnant Günther Rall, the famous Second World War fighter pilot and third highest scorer with 275 victories, all but two of them on the Russian Front. Rall was shot down five times. On 12 May 1944 he was shot down by a USAAF P-47 Thunderbolt and he lost his left thumb in the process. The other pilots on the course comprised five other airmen – Hauptmann Hans-Ulrich Flade, Oberleutnant Berthold Klemm, Edmund Schultz, Oberleutnant Wolfgang von Stürmer and Olt Bernd Kuebart. The first F-104F two-seater was handed over to German military officials in October 1959. Three F-104Fs became available and these were flown by Lockheed test pilots Bob Faulkner, Glen 'Snake' Reaves and Bill Weavers. (Some of the F-104Cs used for pilot training in the United States were later sent to Germany.) After seven days of classroom training, on 22 February 1960, flight training commenced. Each trainee F-104 pilot had to make twenty-six flights and record thirty-two hours' stick time. Each trainee was expected to solo after only two flights with his instructor. Günther Rall was the first 'student' to solo, on 24 February 1960. Rall thus became the first of over 2,000 German Starfighter pilots.

In April 1960 it was Hptm Flade, Klemm, Schultz, von Stürmer, and Kübart who established the training school for *4.Staffel/Waffenschule der Luftwaffe (WaSLw)10* at Nörvenich. Oldenburg, the previous home of *Waffenschule 10*, was unsuitable for Starfighter training because the runway was not long enough and also because the city of Oldenburg nearby would have suffered substantially from the increase in jet-noise. Flade was appointed Kommandant of *4.Staffel.Wafenschule der Luftwaffe (WaSLw)10*, a unit which eventually numbered some 350 staff. Flade, together with Maj Walter Irwin, Capt Chuck Lloyd and Capt Bruce D. Jones, laid down the curriculum for the training schedule.

On the technical side the flying team was supported by twenty staff from Lockheed, General Electric and Lufthansa. After the first German ground crews had been trained in the United States, ground crew training was carried out in Germany at the *Technische Schule der Luftwaffe (TSLW) 1* at Kaufbeuren.

Towards the end of May 1960, the F-104Fs arrived and on 14 July 1960 Bob Faulkner was the first to put one through its paces. In September 1960 the first regular training began and the first five German pilots – Oberleutnante Jürgen Schultess, Heinz Frye, Erhard Gödert, Dietrich Filsinger and Günther Rödel, were destined to fulfil the role of instructors. The first students – Maj Klaus Neumann, Oberleutnante Siegfried Heltzel, Hans-Martin Mudrack, Peter Müller and Eckhardt Schilling – all came from *Jagdbombergeschwader (JaboG)31* 'Böelcke', and they were put through twenty-five hours of flying training on their new aircraft. (Oberstabsfeldwebel Franz-Josef Heltzel was killed flying a Starfighter on 26 October 1973.) In May 1961 *4. Waffenschule 10* acquired another eight instructors – Oberleutnante Bodo Koppe, Joachim Liedtke, Mandred Menzelm Dietrich Schlichting, Hermann-Jósef Sensen, Wolfgang Strenkert, Lutz Tyrkowski and Erwin Willing.

On 29 March 1961 the *Luftwaffe* lost its first Starfighter. Hptm Hans-Ultich Flade and his student, Olt Wolfgang Strenkert, were on a training flight when an engine failure occurred, forcing them to eject from F-104F BB+375 at Korbach. Six months later, on 6 September 1961, Olt Erwin Willing and Olt Hermann Hammerstein had to eject from F-104F BB+378 at Neckarmühlbach. On 25 January 1962 the *Luftwaffe* lost its first pilot killed while flying a Starfighter when Hptm Lutz Tyrkowski and Olt Horst Völter had to eject from F-104F BB+366 at Nörvenich. Vörvenich. Völter survived but Ryrkowski was killed. Four months later, on 22 May 1962, Olt Siegfried Heltzel of *JaboG31* 'B' was forced to eject from F-104G DA+107 at Jülich.

Since not enough F-104Fs were available to satisfy all the training needs, Belgian, Dutch and Italian Starfighter pilots were also trained by the *Luftwaffe*. Maj Thomas Perfili and Captain Jon Speer from the US Air Force Advisory team joined them in training men like Ton van Soest and Henk Vendrig from the Netherlands, Camille Goossens and Rene Janssens from Belgium and Vincenzo Paternico from Italy. Jon Speer was killed flying a F-104G on 19 June 1962, the worst day so far in *WaSLw 10*'s short history, when near Steilkurve, four F-104Fs were lost in a single day. Olts Bernd Kuebart, Heinz Frye and Wolfgang von Stürmer also died in their F-104Fs this day. Tom Perfili died flying a *Luftwaffe* F-104G Starfighter on 2 May 1964.

In the presence of *Inspekteur de Luftwaffe*, General Josef Kammhuber, the first F-104Gs built by Lockheed were handed over to the *Bundeswehr* in August 1961. (Kammhuber was famous in the Second World War for establishing the night fighter division and the 'Kammhuber line'. Kammhuber developed an efficient ground-controlled interception (GCI) technique called *Dunkelnachtjagd*, later *Himmelbett*, which literally translated, is 'bed of heavenly bliss' or 'four-poster bed'). F-104Gs built in California were flight tested before they were disassembled and shipped to Manching, Germany. Four months later, in December 1961, the first F-104G built under licence by *ARGE-Süd* was completed in Manching and plant manager, Willi Langhammer handed the aircraft over to the *Luftwaffe*.

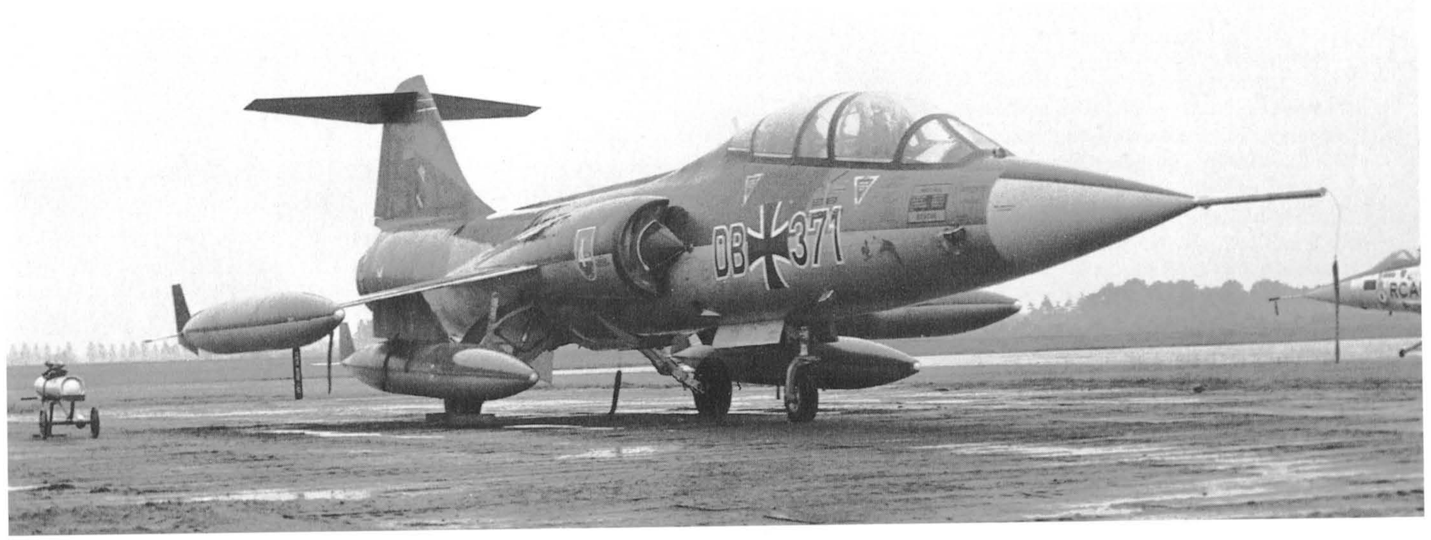
Only a few F-104G models remained in the United States for pilot training by 1962. These aircraft were also used in the Multinational 'Joint Test Force' at Edwards AFB for evaluating sub-system (autopilot and navigation system and so on) before the F-104Gs were shipped to Germany. It was this test force that recommended modifications and additions such as the tailhook for the Starfighter, a second artificial horizon (Standby Attitude Indicator) and the Emergency Nozzle Closure System. These tests were carried out by pilots from all the companies in the countries that formed the European consortium, as well as those from Canada, the United States, and later Japan. Major Heinz Birkenbeil and Oberleutnant Erhard Gödert of the *Luftwaffe* were among the test force personnel. In December 1961, during these tests, Gödert was most probably the first German pilot to fly a F-104G faster than the speed of sound below sea level at Death Valley.

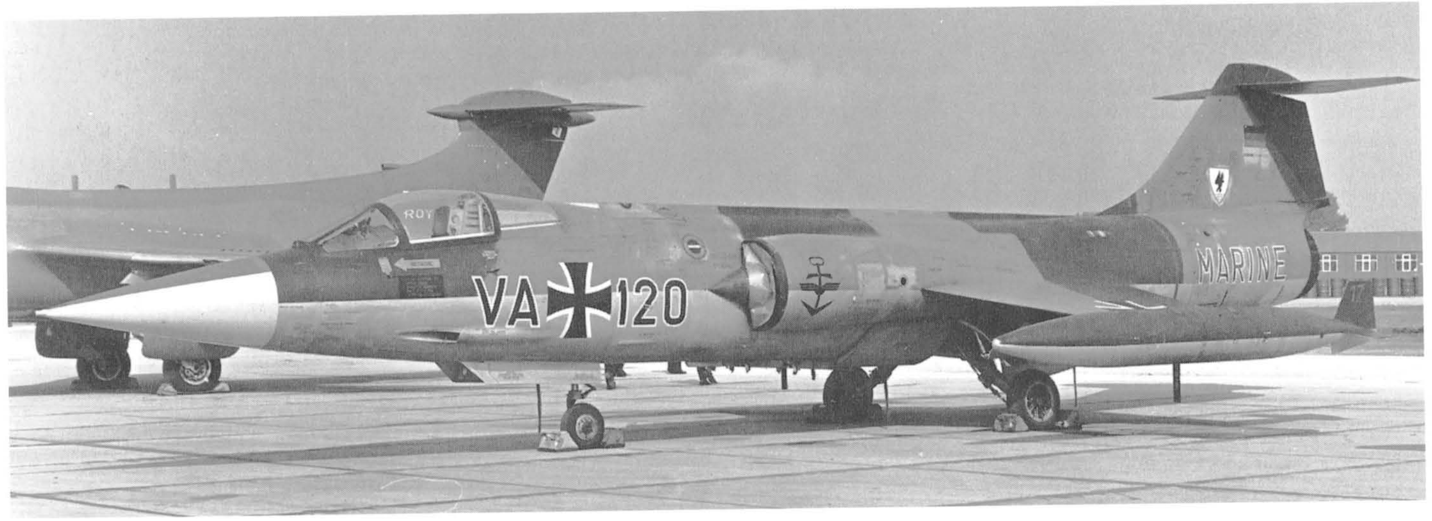
**Starfighters DE+233 (WerkNr2082), and DC+238, a Fokker-built F-104G (8335/KG435), of** JaboG33 **in formation. DR+233 was acquired by the** Türk Hava Kuvvetleri **(THK, Turkish Air Force) in April 1986, flying in 1989 as '9-082' with 9.AHU in Balikesir. DC+238 also went to Turkey, in 1983 and flew in 1987 as '4-087' with 4.AHU in Mürted.** via Philip Jarrett

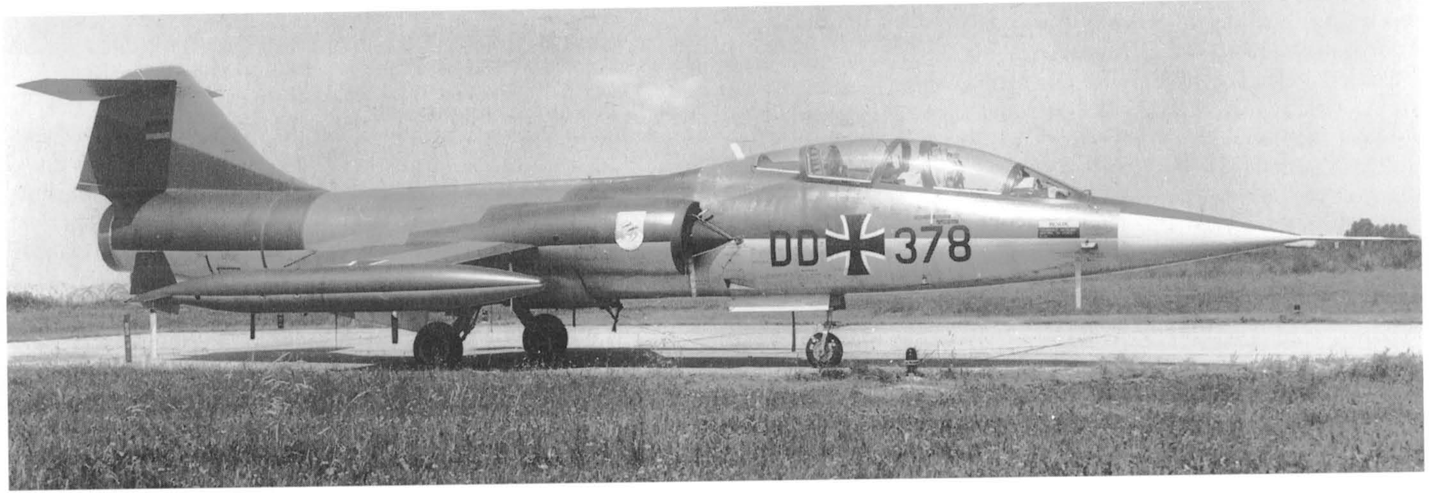
## Luftwaffe *Units*

At its peak, in the mid-1970s, the Starfighter equipped five *Luftwaffe Jagdbombergeschwadern* (Tactical Support units), each of two *staffeln* (squadrons), two *Jagdgeschwadern* (Interceptor units) – also of two *staffeln* each – and two *Aufklärungsgeschwadern* (Tactical Photoreconnaissance units) with four *Staffeln* between them.

The first of the five nuclear-armed *Jagdbombergeschwadern* to be equipped with the Starfighter was *JaboG31* 'Böelcke' at Nörvenich. This unit, which had been the first *Luftwaffe* attack wing when



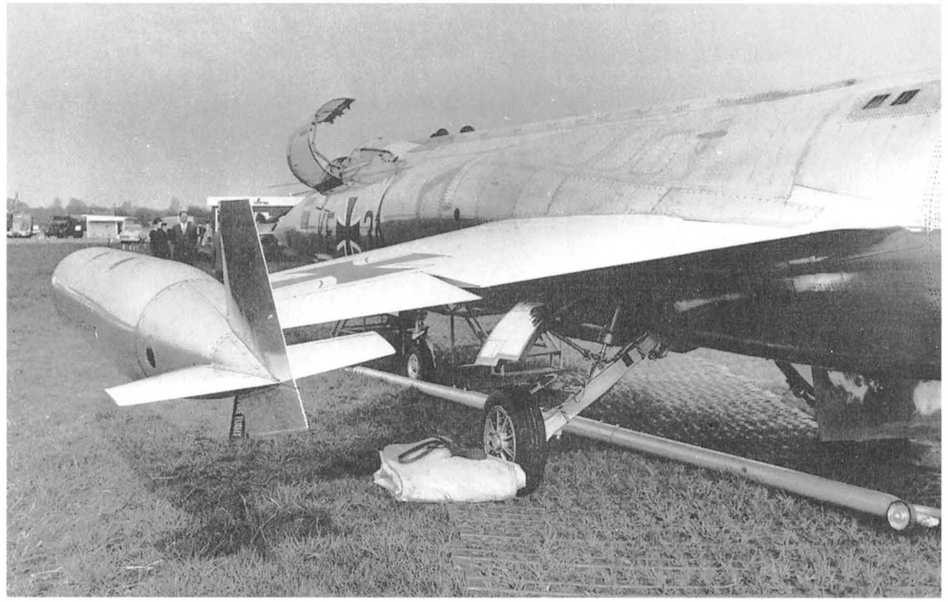




*(Top)* ARGE-Sud **built TF-104G-LO DB+371 of** JaboG32, **pictured on 27 June 1967 during that year's Tactical Weapons Meet, sponsored by AFCENT (Allied Forces Central Europe Command) at RAF Wildenrath. This aircraft went to the** Türk Hava Kuvvetleri (THK, **Turkish Air Force) in 1985 as '4-911' with 4.AHU at Mürted.** via Philip Jarrett

*(Middle)* **Messerschmitt-built F-104G VA+120 (WerkNr7100/KE400) of** MFG **at RNAS Yeovilton. This aircraft crashed on 3 August 1979 at Yeovilton, killing pilot Kptlt Manfred Stürmer.** via Philip Jarrett

*(Bottom)* **TF-104G DD+378 (WerkNr5741) of** JaboG34, **which went to the** Türk Hava Kuvvetleri (THK, **Turkish Air Force) on 3 February 1983.** via Matthias Vogelsang



**F-104G KE+31? of the** Luftwaffe. *Flight*

it formed at Büchel on 1 September 1957 with F-84F Thunderstreaks, began receiving F-104Gs in June 1960 and *311* and *321Staffeln* of *JaboG31* were declared fully operational on 20 February 1962. *JaboG33*, which formed out of *Waffenschule 30* at Büchel on 2 July 1958, also with F-84F Thunderstreaks, received its first F-104Gs in August 1962. Both *331* and *332 Staffeln* of *JaboG33* were declared operational by December 1964. *JaboG31* 'Boelcke' gave up its last F-104G on 30 April 1983 and on 1 August became the first wing in the *Luftwaffe* to re-form as a Tornado IDS (Interdiction and Strike) unit. *JaboG33* flew its last Starfighter sortie on 30 May 1985 and the wing received its first Tornado in September 1985.

The three other *Jagdbombergeschwadern* were *JaboG32* comprising *322* and *323 Staffeln* at Lechfeld; *JaboG34*, comprising *341* and *342 Staffeln* at Memmingen; and *JaboG36*, comprising *361* and *362 Staffeln* at Rheine-Hopsten. *JaboG32*, established on 22 July 1958 with F-84Fs, received its first F-104G on 31 December 1964. *JaboG34*, which had formed at Fassberg on 29 November 1958 with F-84Fs, began receiving Starfighters at Memmingen on 1 July 1964. *JaboG36*, which was formed on 13 March 1961 at Nörvenich on F-84Fs, began receiving F-104Gs on 20 February 1965. *JaboG36* began converting to the F-4F Phantom in 1974 and conversion was completed by mid-1976. *JaboG32* began phasing out the F-104G in April 1984 and began receiving Tornado aircraft on 27 July. *JaboG34* had received additional Starfighters in 1983 to increase the strength of *341* and *342 Staffeln* to around ninety F-104Gs. The wing – the last wing in the *Luftwaffe* to operate the Starfighter – began receiving the Panavia Tornado IDS (Interdiction and strike) in 1987.

The F-104G also equipped two *Jagdgeschwadern* (Interceptor units) – *Jagdgeschwader* (JG)71 'Richthofen' at Wittmundhafen, and *JG74* 'Mölders' at Neuburg. *JG71* has borne the name of Germany's most famous airman since April 1961 when this unit formed at Alhorn as the first day fighter wing of the new *Luftwaffe* in January 1958. *JG71*, which comprises *711* and *712 Staffeln*, received F-86 Sabre Mk.6s on 6 June 1959 and in May 1963, began conversion to the F-104G. *JG71* 'Richthofen' flew the Starfighter until on 7 March 1974, the first F-4E Phantoms arrived to begin a further round of re-equipment.

*JG74*, which comprises *741* and *742 Staffeln* and was formed on 16 July 1959, was the *Luftwaffe*'s first all-weather F-86K Sabre fighter wing. Moving to Neuburg from Leipheim on 1 May 1961, *JG74* flew Sabres until 31 December 1965, although F-104Gs began arriving from 1 July 1964. *JG74* operated the Starfighter in the air defence role until September 1974. The wing began receiving F-4E Phantoms in July that year.

Two *Aufklärungsgeschwadern* (Tactical Photoreconnaissance units) – AG*51* 'Immelmann', comprising *511* and *512 Staffeln* at Ingolstadt/Manching and AG*52*, made up of *521* and *522 Staffeln* at Leck – also received the F-104G Starfighter. In addition, the Starfighter also equipped *Luftwaffenversorgungsregiment 1* – Kommando F-104 at Erding, and a second *Staffel* was

**F-104G Starfighters undergoing maintenance at Manching.** Daimler-Chrysler Aerospace

*(Left)* **F-104G JA+109 of** Jagdgeschwader **(Interceptor unit)** (JG)71 **'Richthofen'**. JG71, **which comprised** 711 **and** 712 Staffeln, **received F-86 Sabre Mk.6s on 6 June 1959 and in May 1963, began conversion to the F-104G.** JG71 **'Richthofen' flew the Starfighter until on 7 March 1974, the first F-4E Phantoms arrived to begin a further round of re-equipment. JA-109 crashed at Ardorf (Wittmundhafen) on 8 March 1972. Hptm Klaus Kegel ejected safely.** *JG71*

*(Below)* **8F-104G JD+248 of** JG74 **'Mölders'. Two F-104Gs of this code flew with** JG74, **one of which crashed on 22 September 1965. Ofw Günter Walzak ejected too late and was drowned. The other F-104G was scrapped in 1974.** via Matthias Vogelsang

added to *Waffenschule 10* after it moved to its new home at Jever on the Upjever aerodrome. Initially, it lacked any F-104G/TF-104G models so between 1961 and 1962 Lockheed trained some fifteen German pilots on the F-104G. These pilots came mostly from *JaboG's 31* and *33*. Training was further supported by additional American pilots who were sent to German units to train pilots on the G model.

Between 1962 and 1964 the 479th TFW also trained German Starfighter pilots on the F-104D at George AFB, California. To instruct pilots on the F-104's radar, initially the NASARR C-47 of the *Flugvermessungsstaffel* in Lechfeld was used. In October 1962 the first TF-104G was flown. Altogether, some 104 TF-104Gs were built for the *Luftwaffe* and the *Marinefliegerdivision* (Navy Flying Division) of the *Bundesmarine* (Federal Navy).

### Marineflieger *Service*

Beginning in spring 1963, two *Marinefliegergeschwadern* (MFG/wings) – *MFG1* at Schleswig, and *MFG2* at Eggebeck – began re-equipping with the F-104G. From 1964 onwards they replaced Hawker Sea Hawks in the anti-shipping role in the Baltic, where they successfully operated on strike/attack and reconnaissance until 1986. From 1977 their Starfighters were armed with a pair of MBB Kormoran anti-shipping missiles in place of the French AS30 missiles. The Kormoran gave the Starfighter the ability to fire at enemy shipping from a distance of 18.6 miles (30km).

The *Marineflieger* received additional ex-*Luftwaffe* F-104Gs and RF-104Gs when the *Aufklärungsgeschwadern* reconnaissance units replaced the latter with the RF-4E Phantom from 1971 to replace those Starfighters lost in accidents.

In all, the *Marineflieger* received 119 F-104Gs and 27 RF-104Gs. *MFG1* operated the F-104G between 1964 and 1 July 1982, while *FG2* operated the Starfighter between 1965 and the summer of 1986; both wings converting to the Panavia Tornado IDS (Interdiction, strike, anti-ship).

## The Losses Mount

In *Luftwaffe* and *Marineflieger* service the Starfighter soon got a poor reputation due to a large number of accidents. By 1965, all NATO Consortium pilots were training in northern Germany, but F-104 accidents began to occur on an increasing scale. They are recalled by Wolfgang Czaia, who had graduated in the USA in 1962 as 'Outstanding Student' and 'Top Gun' at the Fighter Weapons School at Luke AFB, and who flew Republic F-84F Thunderstreaks assigned to *JaboG34* at Memmingen for two years. In 1964 *JaboG34* transitioned to the F-104G and Czaia checked out in November that year. He recalls:

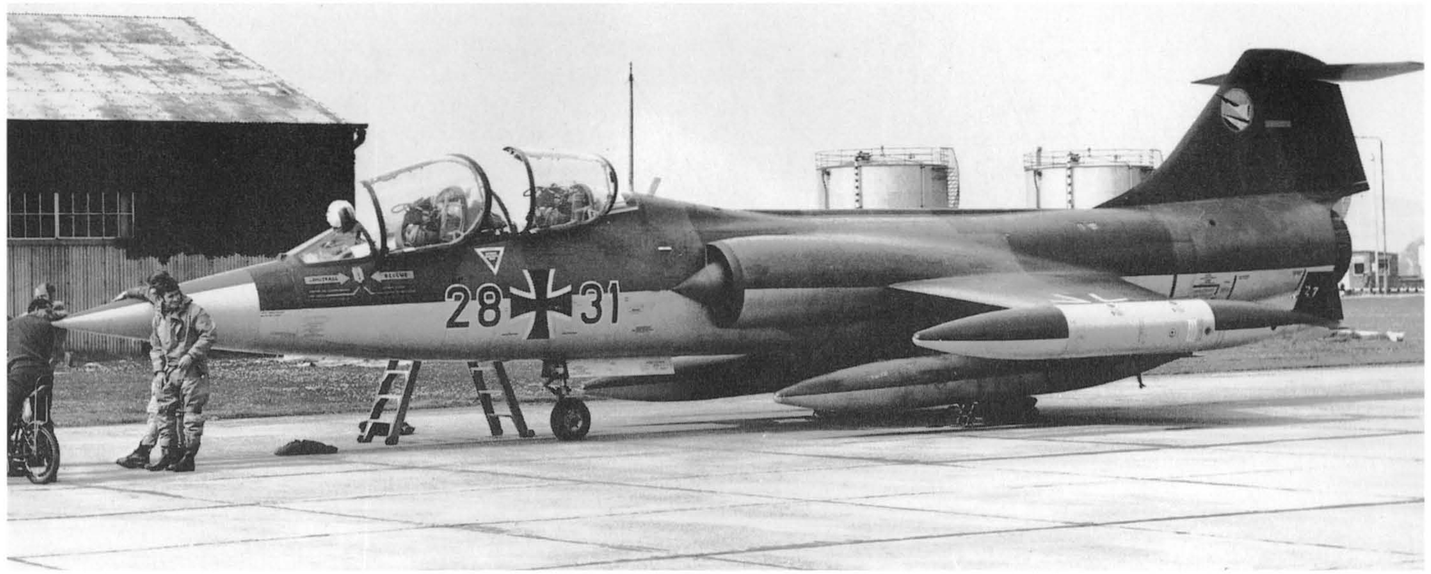
> Many problems with the 104 in the early days were mainly due to the shallow learning curve that maintenance was on. They had to get used to a rather sophisticated technology, and were not able to provide the pilots with the flight hours necessary to build efficiency.[14]

According to the February 1966 issue of *Flying Review International*:

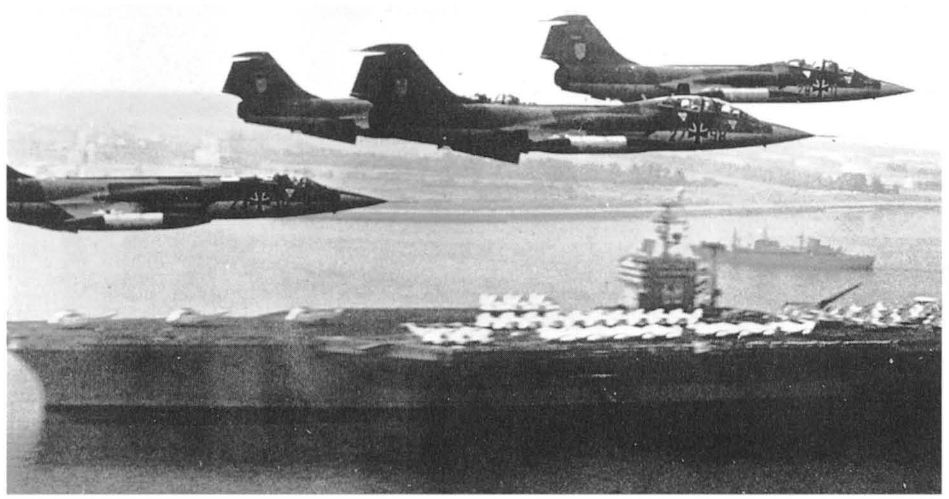
> Much concern is being evinced over the inordinately high *Luftwaffe* loss rate of F-104 Starfighters – some 60 have now been lost in accidents, including 25 last year...Contributory factors include poor maintenance due to the *Luftwaffe*'s acute shortage of skilled technicians, and the inexperience of German pilots who have been averaging only fifteen hours per month, with a consequent loss of proficiency.

Wolfgang Czaia adds:

> For pilots returning from the US, the 104 was their first operational assignment. Most of these guys had never been inside a cloud! They'd always flown in beautiful weather in both Texas and Arizona, and faced radically different conditions in the rather restricted and geographically small airspace of Germany. Even though they went through a 40-hour 'Europeanization' programme at *Luftwaffe* Weapons School 10 at Jever, they

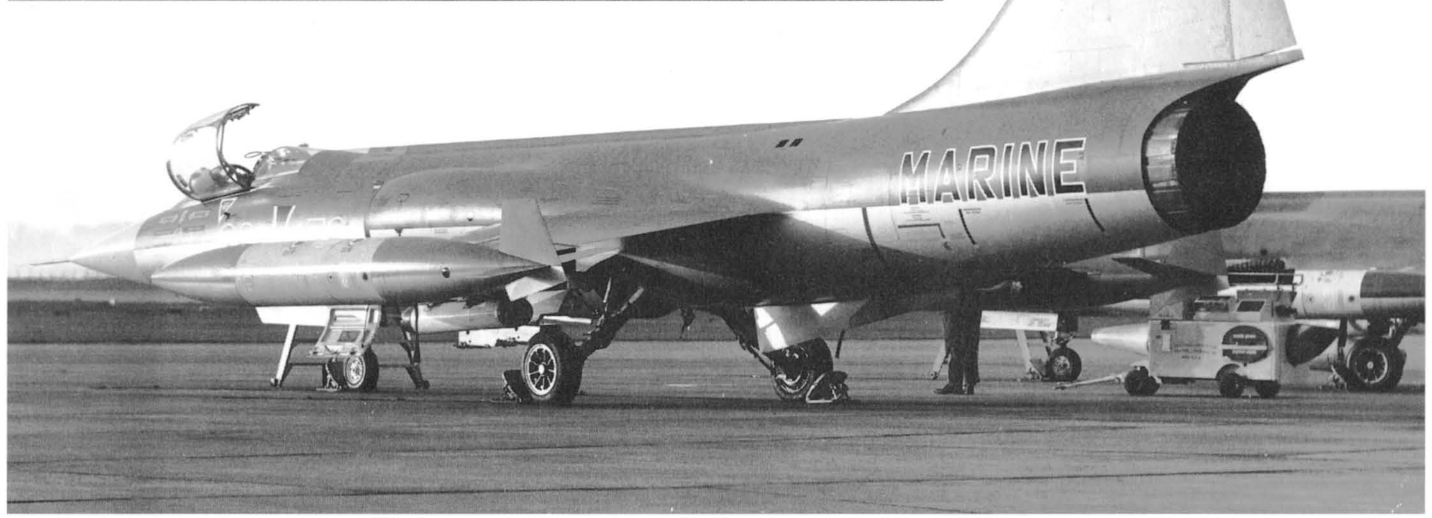


**TF-104G-LO (WerkNr5961) 28+31 of** JG74 **'Mölders'. Beginning in January 1968 the** Kennzeichen **(or serials) applied to** Bundeswehr **aircraft (consisting of two letters and two or three digits) were superseded by new four digit serials like these. 28+31 first flew on 20 November 1967 and served with** JG74 **and** JaboG31, **and in 1983 was the** Blue Boelke 01 **for the 25th anniversary of** JaboG31. **It last served with** JaboG34 **and was acquired by the** Elliniki Vassiliki Aeroporia **(Royal Hellenic Air Force) in November 1989.** via Philip Jarrett



*(Left)* **TF-104G-LOs of WSLw.10 overflying the USS** Nimitz **at Wilhelmshaven. Nearest aircraft is 27+98, which on 5 April 1989 was despatched to the** Elliniki Vassiliki Aeroporia **(Royal Hellenic Air Force) in a C-130. TF-104G 28+11 (right) was lost on 18 July 1983. Hptm Günter Berg and Olt Hartmut Schmidt of** JaboG33 **successfully ejected.** via Matthias Vogelsang

*(Below)* **F-104G of the** Marineflieger. *Aeroplane*



**Messerschmitt-built F-104G 22+57 of** JaboG34. **This aircraft is now on display at the NATO Aircraft Museum at Cleethorpes.** via Matthias Vogelsang

**TF-104G-LO 27+90 of** Aufklärungsgeschwader 52 **at the 1969 Woodbridge Tiger Meet. This aircraft was built in 1965 and served with** AG52, JaboG34, JaboG33, **and** JaboG32, **before being retired at Faßerg with** TSLw3 **(Technical School of the** Luftwaffe**).** via Philip Jarrett

lacked the experience of their Canadian, Italian, Belgian, and Dutch counterparts, who needed to accumulate at least 1,000 hours in operational jets before being even *eligible* to check out in the F-104.

By 1966 the accident rate was unusually high, and a lot of it was weather-related. Quite often small technical problems would – due to the pilots' inexperience and lack of proficiency – be the trigger for chain reactions resulting in accidents. Once the wings began flying steadily and pilots were getting the required flight time the accident rate dropped to 'normal' (ten accidents per 100,000 flight hours) – but the public still perceived it as a dangerous machine, with names like the *Witwenmacher* ('Widow Maker') or *Fliegender Sarg* ('Flying Coffin'). Compounding the problem was that every subsequent ground or flight accident continued to make major headlines. We had just as many accidents in F-84s and F-86s, but these stories would be buried on page 3 or 4.[15]

By 7 December 1967 the *Luftwaffe* had lost 73 F-104s, and 42 pilots and crew killed (including one MFG2 pilot in a Canadian-built, USAF-owned F-104G). Between 4 April 1968 and 12 November 1970, a further twenty-six German pilots and crew (21 *Luftwaffe* personnel and five *Marineflieger* crew) lost their lives in fifty-two (45 *Luftwaffe*/seven *Marineflieger*) Starfighter accidents. All told, by April 1989, the *Luftwaffe* and *Marineflieger* combined had lost, or had written off, 292 Starfighters, with 120 pilots and crew killed. (Also, eight USAF instructor pilots died flying *Luftwaffe* F-104s, 19 June 1962 to 1 July 1975).

Twenty-three *Marineflieger* pilots and crew were killed in the period 18 March 1965 to 17 October 1984. One of these, on 10 March 1979, was Oblt zur see Joachim von Hassel of MFG2, the only son of Herr Kai-uwe von Hassel, president of the Bonn parliament. It was von Hassel who had been Defence Minister at the height of the public outcry in West Germany at the rate of F-104 losses when they had reached one a week. At that time the minister had tried to reassure everyone, saying that he considered the Starfighter a safe aircraft, and that he had no reservations about his son flying it.

Lieutenant Robert Hummel, a US Navy pilot on exchange duty with MFG2 at Eggebeck, had a narrow escape from a Starfighter on 10 July 1984 as he recalled later:

> The Starfighter – a beautiful and sleek machine twenty design years ahead of her time. She could seduce you with her speed, transitioning to hyperspace in a heartbeat. It was the opportunity of a lifetime: NATO exchange duty with a German F-104G squadron in Europe for two and a half years.
>
> As the only naval aviator in the country, I rapidly achieved the qualifications and experience to fly the F/RF-104G throughout the entire operational envelope and was designated 'full combat ready'. The tactical training opportunities in central Europe are unparalleled. The air below 9,000ft belongs to the military, with relatively few operating restrictions. And then there were the Baltic Sea and North Sea operating areas in Ivan's backyard. It was some of the best flying I've ever experienced.
>
> Following final checks, we taxied onto runway 01 in left echelon for a formation go. The tower gave take-off clearance, reporting the winds out of the west at 10 to 15 knots. Engine run-ups and control wipeouts were completed, followed by a thumbs-up from my wingman. I gave the signal to release brakes and light the burner. During this transition phase of engine operation, the nozzle opens up prior to the after-burner igniting and results in a notable loss of thrust for one to three seconds. On this section take-off, my wingman had a quick burner light; I had a slow one. As a result, he ended up acute and accelerating further in front of the lead. It seemed safer to pass him the lead and assume a wing position than have him attempt to re-establish himself in the wing position. I never

**F-104Gs (KG+101, WerkNr8001, right) at the Messerschmitt plant at Manching. KG+101 first flew on 11 November 1961 and was issued to** JaboG31 **from 10 May 1962. It ended its career at Faßerg with** TSLw3 **as an ABDR (Air Battle Damage Repair).** *Aeroplane*

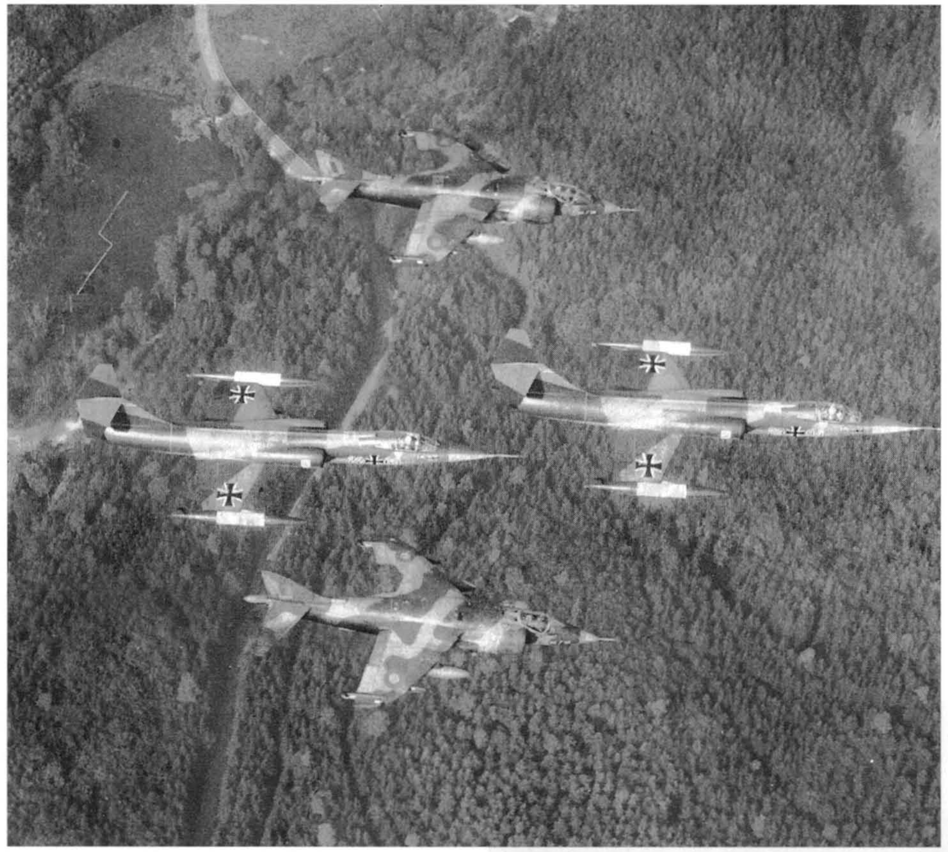
***Luftwaffe/ Marienflieger*** **Starfighter Losses 1961–89**

(Pilots/Crew killed in parentheses)

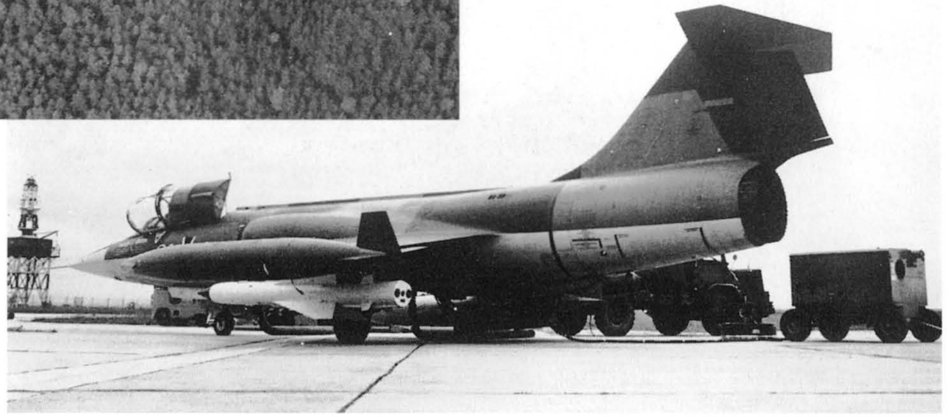
| | *Luftwaffe* | | *MF* | |
|---|---|---|---|---|
| 1961 | 2 | (10) | – | – |
| 1962 | 7 | (6)+ | – | – |
| 1963 | – | – | – | – |
| 1964 | 10 | (3)+ | – | – |
| 1965 | *25 | (15)° | 2 | (2) |
| 1966 | 19 | (10)+ | 3 | (3) |
| 1967 | 11 | (3) | 2 | – |
| 1968 | 15 | (7) | 4 | (4) |
| 1969 | 16 | (9)+ | – | – |
| 1970 | 14 | (5) | 3 | (1) |
| 1971 | 14 | (4) | 5 | (3) |
| 1972 | 11 | (5) | 1 | (1) |
| 1973 | 15 | (5)+ | – | – |
| 1974 | 7 | – | 3 | (2) |
| 1975 | 9 | ( 6)+ | 2 | (1) |
| 1976 | 11 | ( 2) | 1 | – |
| 1977 | 8 | (3) | 2 | (1) |
| 1978 | 10 | (2) | 3 | – |
| 1979 | 5 | – | 5 | (1) |
| 1980 | 10 | (5) | 1 | (1) |
| 1981 | 8 | (2) | 1 | – |
| 1982 | 9 | (2) | 3 | (2) |
| 1983 | 2 | – | – | – |
| 1984 | 6 | (1) | 2 | (1) |
| 1985 | 1 | – | 3 | – |
| 1986 | 1 | – | – | – |
| 1987 | – | – | – | – |
| 1988 | – | – | – | – |
| 1989 | 1 | – | – | – |
| TOTALS | 246 | (97) | 46 | (23) |

*+ inc. 1 USAF; ° inc. 2 USAF; * inc. 1 USAF*

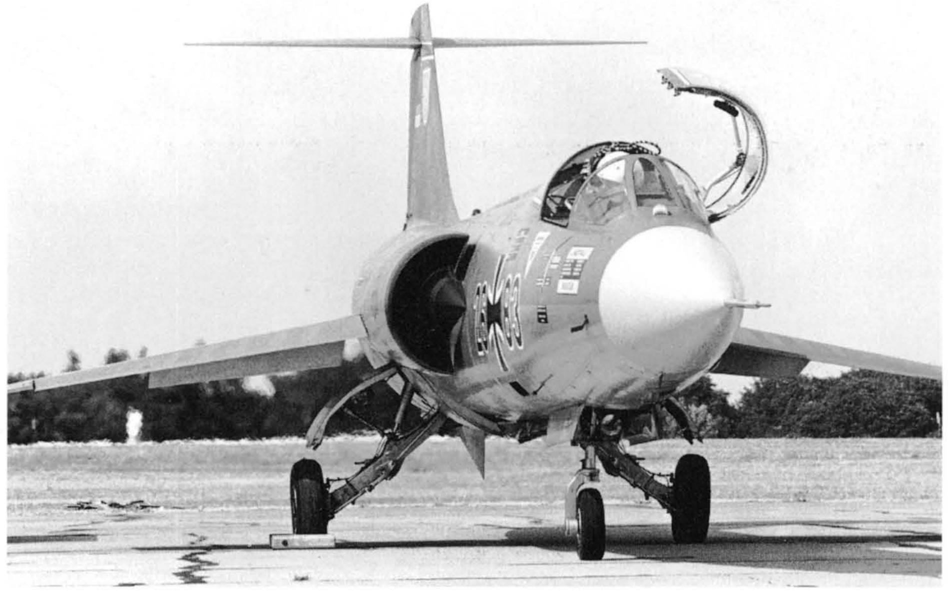
| | |
|---|---|
| Total German F-104 losses | 292 |
| Total German pilots/crew killed | 120 |
| Total USAF pilots killed on German F-104s | 8 |



**RAF Germany Harriers and two F-104G Starfighters 23+94 and 22+63 of the** Luftwaffe **in formation. 23+94 first flew on 18 June 1963 and was issued to** AG51 **on 14 November 1963. It flew with** JaboG34, JaboG31, **and finished its career at Faßerg as an ABDR aircraft. 22+63 first flew on 20 April 1964 and was issued to** JaboG34 **on 9 July 1964. It went on to fly with** WSLw.10 **and** JaboG32 **before being acquired by the** Türk Hava Kuvvetleri (THK, **Turkish Air Force) in 1984 as '9-144' at the 9.AHU in Balikesir.** Bruce Monk



***(Below)*** Marineflieger **F-104G fitted with Komoran anti-shipping missiles, pictured in April 1972.** MBB GmbH



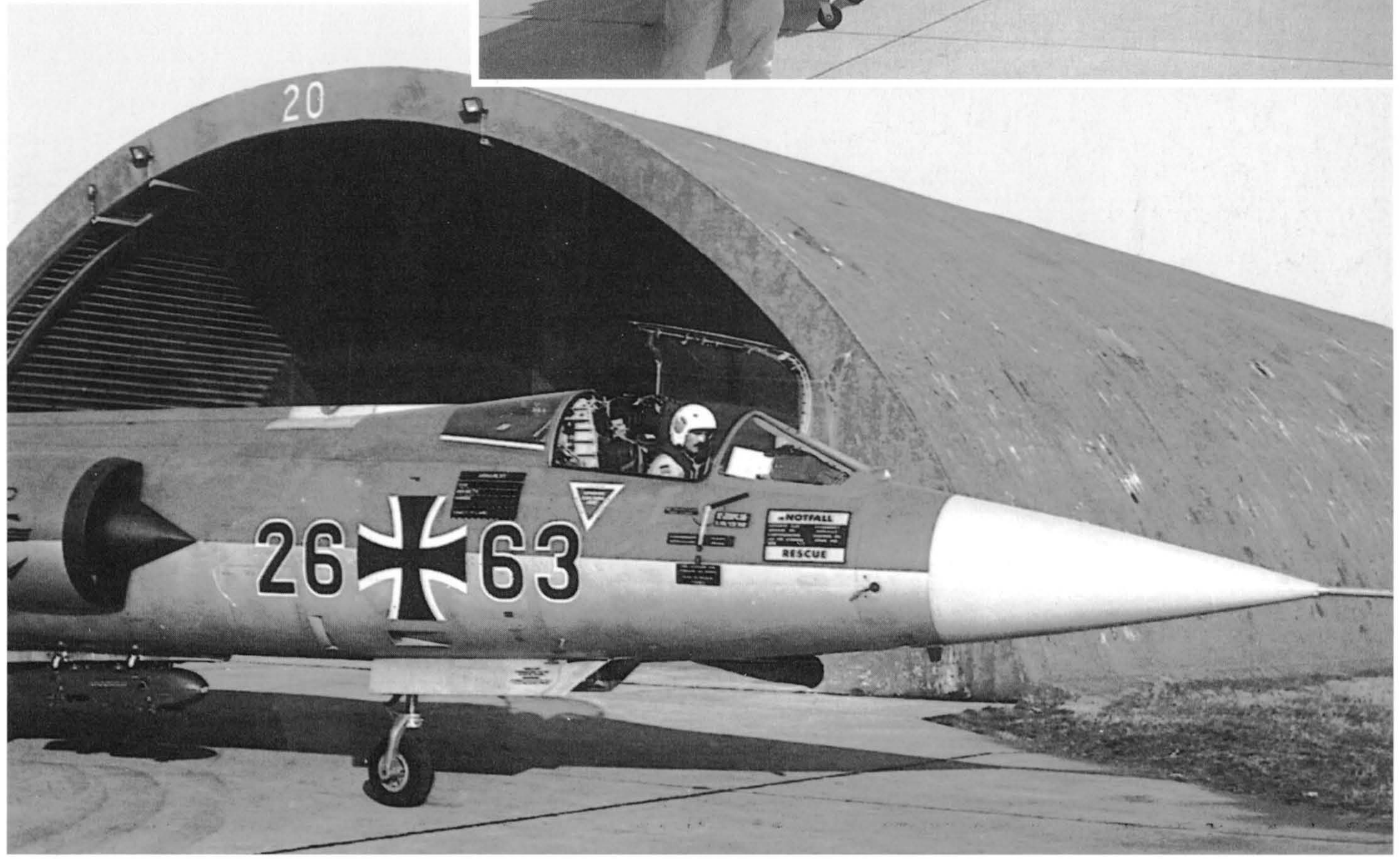
***(Bottom)*** **F-104G 26+83 of the** Marineflieger**. This aircraft first flew on 7 June 1972 and was issued to** MFG1 **on 9 July that year. It went to** MFG.2 **and was acquired by the Greek Air Force in 1989.** via Mike Rondot

thought of aborting. So, a positive lead change was executed in the first 1,000ft to the take-off roll. If I had known then what I know now, I would have aborted and saved a beautiful expensive aircraft.

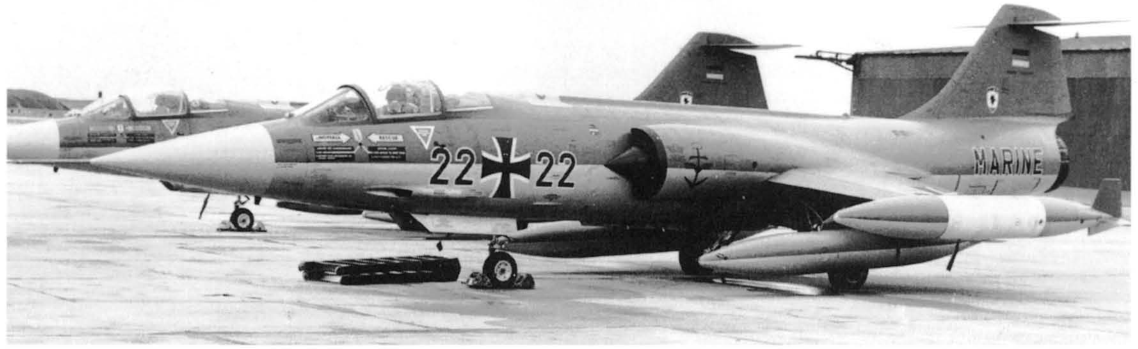
Although I was established in an acceptable wing position at rotation, I was on the downwind side of the formation. The F-104 generates tremendous circulation about the wingtips during take-offs and landings, and the vortices are often visible. Immediately after becoming airborne it became all too clear that things were not quite right. A high-speed abort now was out of the question since the aircraft was already rolling through 10 degrees angle of bank to the left and into my lead. While I held right stick and full right rudder, my Starfighter hesitated for a moment as if the worst was over. Then the left wing began to drop rapidly.

It was time to jettison the reusable container, and I pulled the lower handle of the Martin-Baker MK-GQ7-A ejection seat with my left hand. The aircraft continued to roll and drift as I waited for the eternity of 0.4 seconds to click off. In 30 to 40 degrees angle of bank, at an altitude of maybe six feet, the roll reversed violently to the right. The canopy was gone, but I was still in the aircraft. I think that the left wingtip had impacted the runway. A cartwheeling explosion

Marineflieger **pilot Holger Krohn of** MFG2 **poses for the camera in front of F-104G 23+09. This aircraft first flew on 9 December 1964 and is seen here as a recce-version with** MFG2. **23+09 is now displayed in Eggebek.** Solange Krohn via Matthias Vogelsang



***(Below)*** **Holger Krohn taxies out in F-104G 26+63 of the** Marineflieger. **26+83 first flew on 22 November 1971 and it flew with both** MFG1 **and 2. It was part of the Vikings display team and this aircraft was also painted in the special Vikings' colour scheme of blue, white and red (the colours of Schleswig-Holstein). It went to the** Elliniki Vassiliki Aeroporia **(Royal Hellenic Air Force) on 27 April 1988 where it served with the** 116 Ptérix Mahis **(Combat Wing) in Araxos before being phased out at Hellinikon.** Solange Krohn via Matthias Vogelsang



**F-104G 22+22 of** MFG1. **22+22 first flew on 26 August 1963. After** Marineflieger **service, this aircraft was acquired by the** Elliniki Vassiliki Aeroporia **(Royal Hellenic Air Force) on 22 October 1980 where it served with the** 116 Ptérix Mahis **(Combat Wing) in Araxos.** via Philip Jarrett

***(Top)*** **TF-104G 28+29 of** JaboG38 **getting airborne. 28+29 first flew on 12 October 1967 and was issued to** WaSLw.**10. It also flew with** JaboG33 **and** JaboG34 **before going to the** Elliniki Vassiliki Aeroporia **(Royal Hellenic Air Force) on 4 March 1986.** via Matthias Vogelsang

***(Middle)*** **TF-104G 27+96 of** WaSLw.10. **27+96 was built in 1966 and was issued to** WaSLw.10, **flying later with** JaboG33, **and** JaboG34. via Matthias Vogelsang

**TF-104G 28+16 of** JaboG38. **28+16 first flew on 16 June 1967 and was assigned to** JaboG36 **that same year. It also flew with** JaboG32, WaSLw.10 **and** JaboG31 **before joining the AMI (Italian Air force) on 10 August 1984, as MM54558 in** 20° Gruppo **at Grosseto.** via Matthias Vogelsang

had to follow in the very next instant as the wing was ripped off.

If only I had initiated ejection earlier! If only I had aborted when I first detected the lack of roll control after rotation! I heard the roar of the ejection seat rockets and felt the acceleration as I was catapulted clear of my lost craft. I was now an ejection statistic [the 5,338th life saved by a Martin-Baker seat]. The seat worked perfectly, giving me about half a swing before landing dead centre on the runway. From initial aircraft rotation to nylon landing was about ten seconds. The crosswind dragged me across the runway about 50ft until I managed to release my chute. I just lay there on the runway for a moment, waiting for it to start hurting somewhere, then initiated a functional check of the major body parts. They were all still attached: I was, in fact, uninjured. The same could not be said for Starfighter 23+18. She was a twisted mass of fire and metal about a quarter mile away; her flames were being suppressed by the quickly responding crash crew. She became the 191st Starfighter to crash, and it wasn't her fault.

In retrospect, the take-off should have been aborted when the non-notice lead change occurred. Speeds are slow, and control of the aircraft is easily maintained. The effects of wingtip vortices cannot be underestimated. Whether during formation or flight leader separation take-offs, sufficient wingtip-to-wingtip separation must be maintained to ensure avoidance of the vortices, which can wrestle control of your aircraft out of your hands in the blink of an eye.

Know the performance capabilities and characteristics of your aircraft. There are very few aircraft that don't give ample indications of impending departure from controlled flight. Know these indications and listen out for them when you are operating at or near the edge of the performance envelope.

Know when it's time to jettison the reusable container. The best time to think about ejection situations is in the ready room or at midrats with some of your squadron mates.

## Starfighter Phaseout

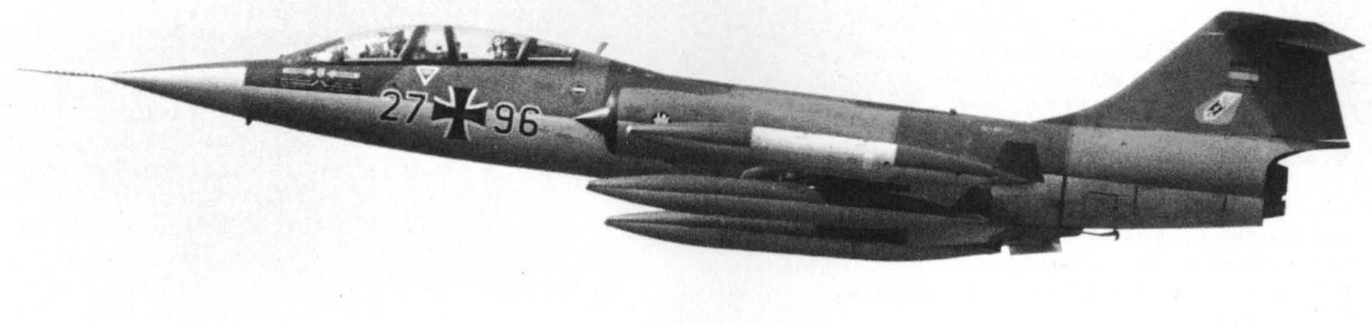
Starfighter phaseout began in 1971 when *AKG51* and *AKG52* received McDonnel RF-4Es, while two *Jagdgeschwarden* re-equipped with F-4Fs in 1973–74 and *JBG36* obtained Phantom IIs in 1976. In other units, the scheduled replacement of Starfighters by Tornadoes got underway in 1982 and by the mid-1980s the F/TF-104Gs were fast disappearing from German

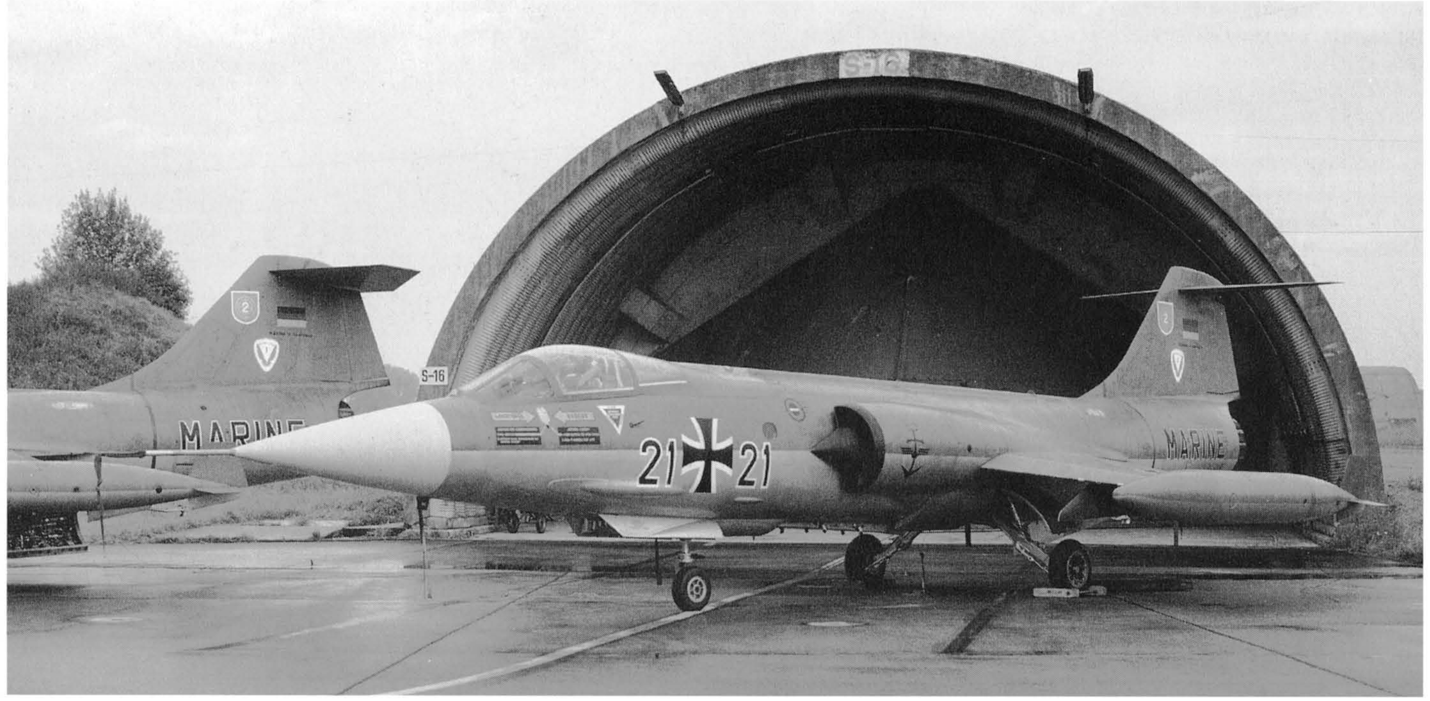
**F-104Gs 24+28 and 21+64 of** JaboG38 **of the** Luftwaffe **in formation. 24+28 first flew on 12 November 1963 and was issued to** WaSLw.10, **later** JaboG32 **also. 24+28 crashed on 8 July 1980 near Cap della Frasca, Sardinia, after touching the sea. The pilot, Lieutenant Béla Blanca, was killed. 21+64 first flew 7 March 1963 and was issued to** JaboG33 **that same year. It later served with** JaboG31, JaboG34, **and the** WaSLw.10. **21+64 finished as an ADBR aircraft at Sylt.** via Matthias Vogelsang

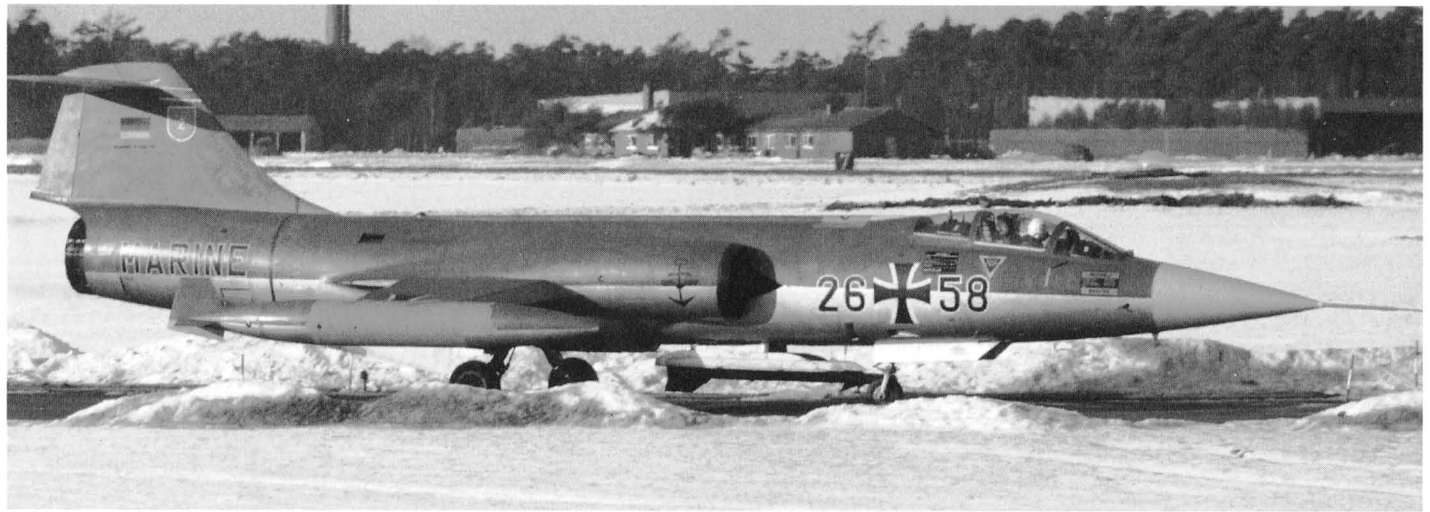
***(Left)*** **F-104Gs of the** LVR1 (Luftwaffen Versorgungs Regiment), **some awaiting disposal, others pending shipment to other NATO air arms like Greece and Turkey. Nearest is 26+51 with 25+59 behind. 26+51 first flew on 21 July 1971 and was issued to** JaboG33 **that same year. 25+59 first flew on 7 July 1962 and flew with** JaboG31. **It was used on the SATS (Short Airfield for Tactical Support) Programme at the US Navy Test Center at Lakehurst, New Jersey in 1964–65. It was acquired by the** Türk Hava Kuvvetleri (THK, **Turkish Air Force) on 10 April 1986.** Roland W. Albrecht via Matthias Vogelsang

***(Right)*** **F-104Gs 21+91, 20+61 and 21+98 of** JaboG33 **in formation. 21+91 first flew on 19 April 1983 and was issued to** JaboG33. **It also flew with** JaboG34. **It is now displayed at the** Ailes Anciennes **in Toulouse, France. 20+61 was built in 1962 and was issued to** JaboG33. **It also flew with WaSLw.10 and was acquired by the** Türk Hava Kuvvetleri (THK, **Turkish Air Force) on 10 April 1984 as '9-070' with the 9.AHU at Balikesire. 21+98 first flew on 7 May 1963, and was issued to** JaboG33. **This aircraft suffered an accident on 13 March 1976 at Büchel, was repaired, and later served with** JaboG34. **It went to the** THK **on 16 September 1986, as '9-067' at 9.AHU, Balikesir.** via Matthias Vogelsang

***(Below)*** **TF-104G 27+96 of** JaboG33. **This Starfighter was acquired by the** Türk Hava Kuvvetleri (THK, **Turkish Air Force) on 21 January 1986 as '9-926' at 9.AHU Balikesir.** via Matthias Vogelsang



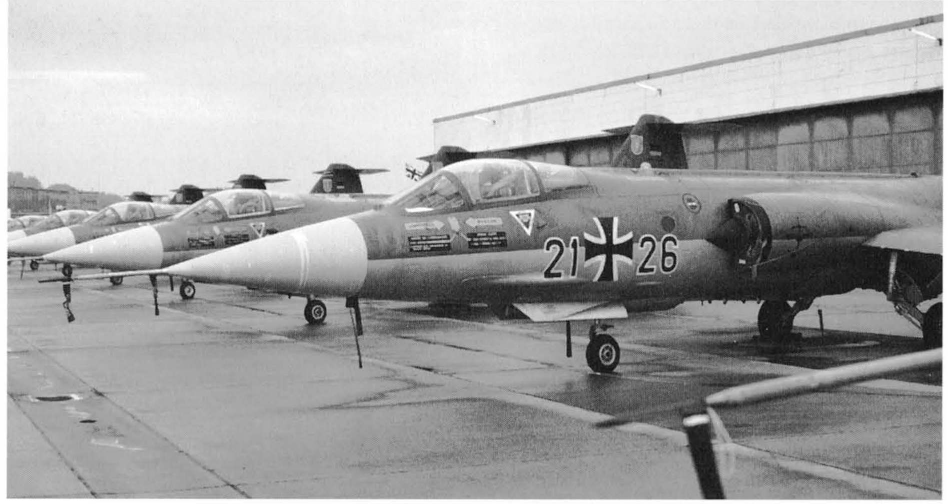




***(Top)* RF-104G 21+21 of** MFG2 **of the** Marineflieger **at Erding on 13 September 1986. This Starfighter was built in Italy and first flew on 3 May 1965. In 1987 it was acquired by the** Elliniki Vassiliki Aeroporia **(Royal Hellenic Air Force) and served with the** 116 Ptérix Mahis **(Combat Wing) at Araxos.** Matthias Vogelsang

***(Above)* F-104G 26+58 of** MFG2 **of the** Marineflieger **taxies past in the snow at Jever on 24 January 1985. This Starfighter first flew on 18 October 1971. It was acquired by the** Türk Hava Kuvvetleri **(THK, Turkish Air Force) on 24 November 1986.** Matthias Vogelsang

**F-104Gs of MFG2 of the** Marineflieger **at Erding on 13 September 1986. Nearest Starfighter is 21+26. This Starfighter was built in Italy and first flew on 23 June 1965. It serves today as an ABDR at Faßberg at TSLw 3.** Matthias Vogelsang



**Oberleutnant 'Blacky' Schwartz of** MFG1 **gives the signal to power up his F-104G (27+77).**
Matthias Vogelsang

skies. Large numbers of Starfighters were then transferred to allies. Italy received six ex-German TF-104G Starfighters, Greece received 58 F-104Gs and 23 TF-104Gs, and 39 F-104Gs and 27 TF-104Gs were handed back to the USAF for onward shipment to Taiwan (three ex-*Luftwaffe* F-104G/TF-104Gs were given to NASA), while Turkey received 165 F-104Gs and 36 TF-104Gs.

In Germany, *JaboG34* was the last Starfighter operational unit when it finally retired the F-104G in October 1987. Other F/TF-104Gs were used by *LwWersRgt 1* at Erding, and *Eprobungstelle 61*, a test unit, at Manching. *WTD61* had the honour of flying the last German Starfighter sorties, in May 1991.

**Starfighter Production for the *Luftwaffe/Marineflieger***

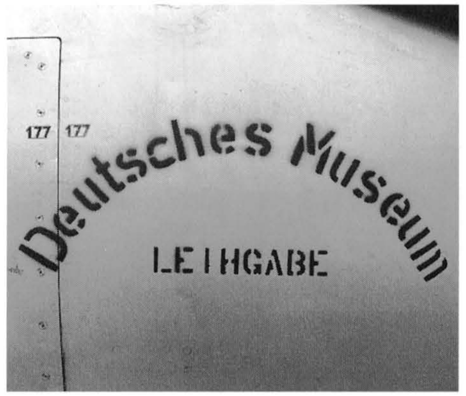
*LOCKHEED/CO-PRODUCED*

| *Serials* | *Type* | *No. Built* |
|---|---|---|
| 59-4994/5023 | F-104F-LO | 30 |
| (BB360/BB389)+ | | |
| 61-3031/84 | TF-104G-LO/MSP | 54 |
| 63-8452/69 | TF-104G-LO/MSP | 18 |
| KF201/KF232 | TF-104G-LO | 32 |
| 66-13622/31 | TF-104G-LO | 10 |
| KE201/KE223 | TF-104G-LO/co-pro | 23 |
| KF101/KF109 | TF-104G-LO | 9 |
| 63-13259 | F-104G-LO | 1 |
| 63-13230/35 | F-104G-LO | 6 |
| KF117 | F-104G-LO | 1 |
| 63-13236 | F-104G-LO | 1 |
| KF199 | F-104G-LO | 1 |
| 63-13237/45 | F-104G-LO | 9 |
| KF129 | F-104G-LO | 1 |
| 63-13246/258 | F-104G-LO | 13 |
| KF143/KF150 | F-104G-LO | 8 |
| KF151/KF174 | F-104G-LO | 24 |
| 63-13260 | F-104G-LO | 1 |
| KF176/KF184 | F-104G-LO | 9 |
| 63-13262 | F-104G-LO | 1 |
| KF186/KF189 | F-104G-LO | 4 |
| 63-13263/13265 | F-104G-LO | 3 |
| KF-193 | F-104G-LO | 1 |
| 63-13266/13268 | F-104G-LO | 3 |
| 63-13274 | F-104G-LO | 1 * |
| TOTAL | | 264 |

**Pattern aircraft for SABCA: + After 1.1.68: 2901/2930*

*FIAT*

| *Serials* | *Type* | *No. Built* |
|---|---|---|
| KC101/KC150 | F-104G | 50 |
| TOTAL | | 50 |



**Whoever said that the Starfighters were too long in the tooth? F-104G 26+75 of** MFG2 **of the** Marineflieger **with its 'tongue-in-cheek' logo,** Deutches Museum Leihgabe, **which translated, reads: 'on loan from the German museum'! This Starfighter, which first flew on 29 March 1972, was acquired by the** Elliniki Vassiliki Aeroporia **(Royal Hellenic Air Force) in 1989.** Matthias Vogelsang

*MESSERSCHMITT-BOLKOW-BLOHM (MBB)*

| *Serials* | *Type* | *No. Built* |
|---|---|---|
| 2641/2654 | F-104G | 14 |
| 2655/2690 | F-104G | 36 |
| TOTAL | | 50 |

*MESSERSCHMITT*

| *Serials* | *Type* | *No. Built* |
|---|---|---|
| 63-13526 | F-104G | 1 |
| 64-12745 | F-104G | 1 |
| 64-12747 | F-104G | 1 |
| 64-12748 | F-104G | 1 |
| 66-13524 | F-104G | 1 |
| 66-13525 | F-104G | 1 |
| 67-14885 | F-104G | 1 |
| 67-14886 | F-104G | 1 |
| 67-14888 | F-104G | 1 |
| 67-14889 | F-104G | 1 |
| KE302/KE306 | F-104G | 5 |
| KE399/KE419 | F-104G | 21 |
| KE308/KE314 | F-104G | 7 |
| KE421/KE431 | F-104G | 11 |
| KE316/KE322 | F-104G | 7 |
| KE434/KE476 | F-104G | 43 |
| KE324/KE338 | F-104G | 15 |
| KE340/KE397 | F-104G | 58 |
| KE478/KE510 | F-104G | 33 |
| TOTAL | | 210 |

*(continued overleaf)*

**Starfighter Production for the *Luftwaffe*/*Marineflieger*** *(continued)*

*FOKKER*

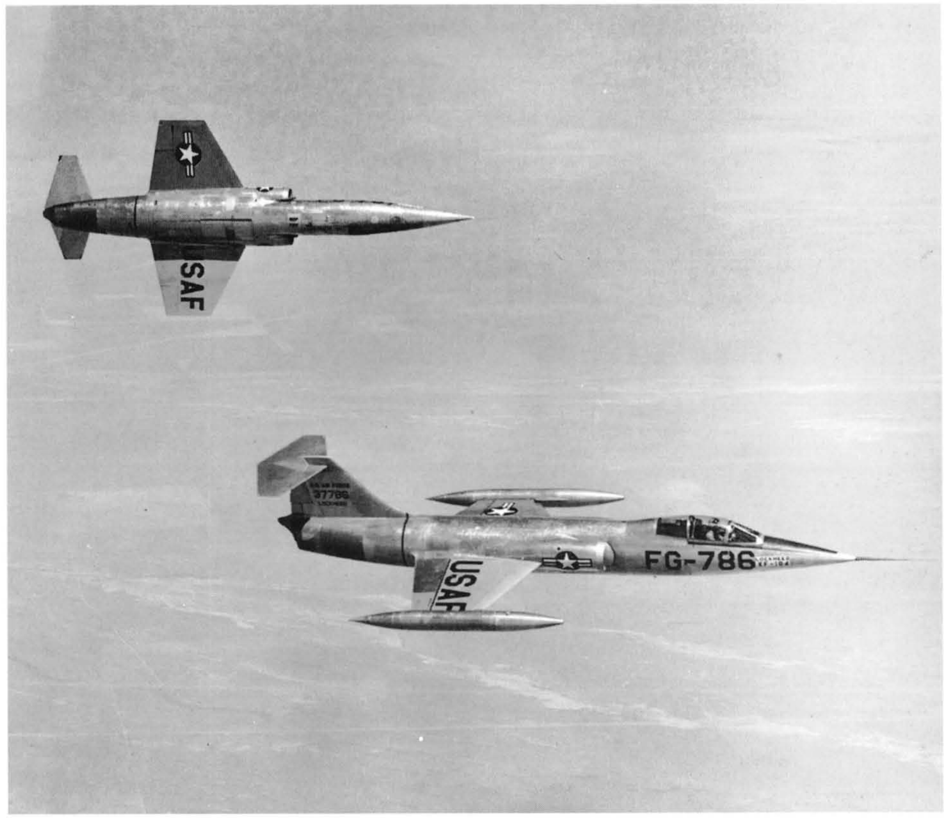
| *Serials* | *Type* | *No. Built* |
|---|---|---|
| KG101 | F-104G | 1 |
| 63-13269 (KG102) | F-104G | 1 |
| 63-13270 (KG103) | F-104G | 1 |
| KG104/KG106 | F-104G | 3 |
| 63-13271 (KG107) | F-104G | 1 |
| 63-13272 (KG108) | F-104G | 1 |
| 63-13273 (KG109) | F-104G | 1 |
| KG110/KG120 | F-104G | 10 |
| 64-12746 (KG121) | F-104G | 1 |
| KG123/KG155 | F-104G | 25 |
| 63-13229 (KG156) | F-104G | 1 |
| 64-12749 (KG157) | F-104G | 1 |
| 64-12750 (KG158) | F-104G | 1 |
| 64-12751 (KG159) | F-104G | 1 |
| 64-12752 (KG160) | F-104G | 1 |
| KG170 | F-104G | 1 |
| 64-12753 (KG171) | F-104G | 1 |
| KG172/KG176 | F-104G | 5 |
| 64-12754 (KG177) | F-104G | 1 |
| KG178/KG181 | F-104G | 4 |
| KG185/KG187 | RF-104G | 3 |
| KG188 | F-104G | 1 |
| KG192 | F-104G | 1 |
| KG194/KG195 | RF-104G | 2 |
| KG196/KG197 | F-104G | 2 |
| KG200 | F-104G | 1 |
| KG202 | RF-104G | 1 |
| KG206 | RF-104G | 1 |
| KG208 | RF-104G | 1 |
| KG211 | RF-104G | 1 |
| KG213 | RF-104G | 1 |
| KG216 | RF-104G | 1 |
| KG218 | RF-104G | 1 |
| KG222 | RF-104G | 1 |
| KG224 | RF-104G | 1 |
| KG226 | RF-104G | 1 |
| KG228 | RF-104G | 1 |
| KG230 | RF-104G | 1 |
| KG232 | RF-104G | 1 |
| KG234 | RF104G | 1 |
| KG236/KG237 | RF-104G | 2 |
| KG239/KG240 | RF-104G | 2 |
| KG242 | RF-104G | 1 |
| KG244 | RF-104G | 1 |
| KG246 | RF-104G | 1 |
| KG248/KG261 | RF-104G | 14 |
| KG262 | F-104G | 1 |
| KG263/KG265 | RF-104G | 3 |
| KG266 | F-104G | 1 |
| KG267 | RF-104G | 1 |
| KG268/KG270 | F-104G | 3 |
| KG271 | RF-104G | 1 |
| KG272 | F-104G | 1 |
| KG273/KG274 | RF-104G | 2 |
| KG275 | F-104G | 1 |
| KG276 | RF-104G | 1 |
| 67-14893(KG277) | F-104G | 1 |
| KG278 | F-104G | 1 |
| KG279/KG281 | RF-104G | 3 |
| KG282 | F-104G | 1 |
| 63-13690(KG283) | F-104G | 1 |
| KG284/KG287 | F-104G | 4 |
| 63-13691(KG288) | F-104G | 1 |
| KG289/KG290 | F-104G | 2 |
| 67-14890/91(KG291/92) | RF-104G | 1 |
| KG293/KG295 | F-104G | 3 |
| 63-13261(KG296) | F-104G | 1 |
| KG297/KG303 | F-104G | 7 |
| 67-14890(KG304) | RF-104G | 2 |
| KG305/KG306 | RF-104G | 2 |
| KG307 | F-104G | 1 |
| KG308/KG311 | RF-104G | 4 |
| KG312 | F-104G | 1 |
| KG313/KG315 | RF-104G | 3 |
| KG316 | F-104G | 1 |
| KG317/KG319 | RF-104G | 3 |
| KG320 | F-104G | 1 |
| KG321/KG323 | RF-104G | 3 |
| KG324 | F-104G | 1 |
| KG325/KG327 | RF-104G | 3 |
| KG328 | F-104G | 1 |
| KG329/KG330 | RF-104G | 2 |
| KG331 | F-104G | 1 |
| KG332/KG333 | RF-104G | 2 |
| KG334 | F-104G | 1 |
| KG335/KG336 | RF-104G | 2 |
| KG337 | F-104G | 1 |
| KG338/KG349 | RF-104G | 9 |
| KG350 | F-104G | 1 |
| KG351/KG355 | RF-104G | 5 |
| KG361/KG362 | RF-104G | 2 |
| KG363 | F-104G | 1 |
| KG364/KG365 | RF-104G | 2 |
| KG369/KG371 | RF-104G | 3 |
| KG374 | RF-104G | 1 |
| KG375 | F-104G | 1 |
| KG376 | RF-104G | 1 |
| KG377/KG378 | F-104G | 2 |
| KG384/KG385 | F-104G | 2 |
| KG387 | F-104G | 1 |
| KG389/KG392 | F-104G | 4 |
| KG395/KG396 | F-104G | 2 |
| KG398/KG399 | F-104G | 2 |
| KG401/KG403 | F-104G | 3 |
| KG405/KG407 | F-104G | 3 |
| KG409/KG410 | F-104G | 2 |
| KG413/KG417 | F-104G | 5 |
| KG420/KG423 | F-104G | 4 |
| KG427/KG430 | F-104G | 4 |
| KG433/KG435 | F-104G | 3 |
| KG439/KG440 | F-104G | 2 |
| KG444/KG450 | F-104G | 7 |
| D-8054 | F-104G<br>(From *KLu* 1963) | 1 |
| TOTAL | | 255 |

*SABCA*

| *Serials* | *Type* | *No. Built* |
|---|---|---|
| 63-13275/13278 | F-104G | 4 |
| KH106/KH188 | F-104G | 83 |
| TOTAL | | 87 |

CHAPTER FOUR

# Versions and Project Models



**The two XF-104s (Model 083-92-01) (53-7786 and 53-7787) in formation. Both aircraft were later lost in crashes during the testing programme.** Lockheed

## XF-104-LO (Model 083-92-01)

Designation applied to two single-seat tactical fighter prototypes (53-7786/7787), ordered on 12 March 1953, with Wright XJ65-W-6 engines of 7,800lb static thrust (3,540kg) and 10,200lb (4,630kg) with afterburner. The first flight, with non-afterburning engine, took place on 4 March 1954. The maximum speed reached by the XF-104, with the afterburner working, was Mach 1.79. A downward-ejection seat was fitted and provision made for a 20mm six-barrel M-61 Vulcan cannon.

## YF-104A-LO (Model 183-93-02)

Designation applied to 17 aircraft (55-2955/2971) of the pre-production series ordered in October 1954. The YF-104A differed from the XF-104 by its longer fuselage of 5ft 6in (1.67m), by modifications to the air intakes, and by the new engine, General Electric YJ79-GE-3 with a maximum thrust rating of 9,300lb static thrust (4,218kg) and 14,800lb (6,713kg) with afterburner. Later, the equally powerful J79-GE-3A with improved afterburner was standardized. The first flight took place on 17 February 1956 and reached Mach 2 on 27 April 1956. The seventh YF-104A (55-2961) was transferred to NASA in August 1956.

**YF-104A 55-2956, the second of the seventeen YF-104As built. Like three others, 55-2956 later became a QF-104A drone.** Lockheed

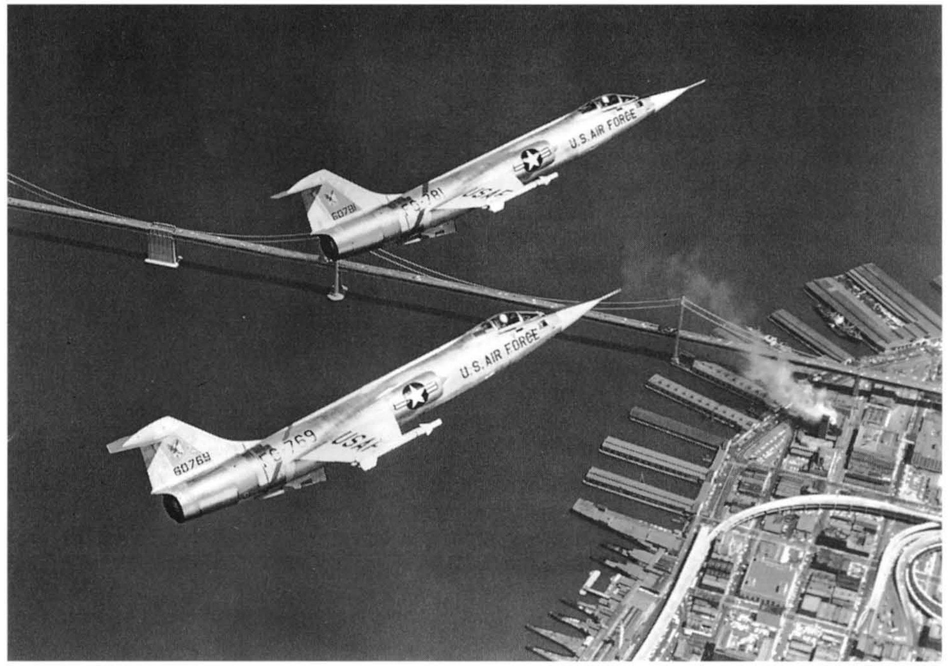
## F-104A-LO (Model 183-92-02)

First series production (fighter-bomber) of the F-104, very similar to the YF-104A. Some 153 examples were ordered (F-104A-1; 56-730/736; F-104A-5; 56-737/737; F-104A-10; 56-748/763; F-104A-15; 56-764/788; F-104A-20; 56-789/825; F-104A-25; 56-826/877; F-104A-30; 56-878/882). The first F-104A flew in February 1956. Last deliveries to the US Air Force were in December 1958.

Power initially was provided by a General Electric J79-GE-3A of 9,600lb static thrust (4,354kg) and 14,800lb (6,713kg) with afterburner, but beginning in April 1958, F-104As were retrofitted with the more reliable J79-GE-3B engine. A further retrofit saw the J79-GE-19 of 17,900lb (8,119kg) afterburning thrust on some USAF aircraft. Design armament consisted of a 20mm M-61 Vulcan cannon and two AIM-9B Sidewinder air-to-air missiles with AN/ASG-14T-1 fire control system. Unreliability of the early cannon in November 1957 resulted in its removal before delivery of F-104As to Air Defense Command, and the improved M-61A1 cannon was reinstalled in 1964. During operational service use the Lockheed-designed downward-firing ejection seat was replaced by a Lockheed-designed upward-firing seat (C-2) and standard installation of the ventral fin and flap-blowing system. Ten F-104As were given to Pakistan, and these were later retrofitted with the J79-GE-11A of 15,800lb (7,167kg) maximum thrust. Forty-six went to the Republic of China Air Force (RoCAF) on Formosa (Taiwan), and 32 were given to Jordan. Three went to NASA (56-734 and 56-749 between October 1957 and December 1962 and, when 56-749 crashed, 56-790, acquired in December 1966), and one (F-104A-15-LO 56-770) went to Canada as a prototype to initiate the production in this country. In 1960, 24 F-104As were modified to QF-104A target drones, and three as NF-104s (56-756, 56-760 and 56-762).

## NF-104A Aerospace/Astronaut Proficiency Trainer

Designation applied to three F-104As (56-756, 56-760 and 56-762) modified for use in training candidate astronauts at the USAF Aerospace Research Pilots School (ARPS) at Edwards AFB, California (*see* Chapter 9).



**F-104A-15-LO models 56-0769 and 56-0781 of Air Defense Command in formation.** Lockheed

**QF-104A (F-104A) drone 56-071 in dayglo red. The first flight of a QF-104A drone occurred in late 1960. The final QF-104A drone operations were carried out in the early 1970s.** Philip Jarrett

## QF-104A-LO

Designation applied to four YF-104As (55-2956/57, 55-2969 and 55-2971) and twenty early production F-104As modified in 1959–60 by Lockheed in conjunction with the Sperry-Phoenix Company as remote-control target drones. These could be flown by onboard pilots, pilots with remote-control from other aircraft, and pilots on the ground with radio-control equipment. Initially, six QF-104As were to be maintained for use at Eglin AFB Auxiliary Field Number 3, with the remaining drones to be maintained in storage at Sacramento ALC (the depot responsible or F-104 support) until they were required for use to replace expended drones (QF-104As were rarely destroyed – each cost $1.7 million – and were normally recovered and used later in testing the Boeing IM-99A and IM-99B Bomarc air defence missile). The QF-104A was designed to work in conjunction with a DT-33A airborne director aircraft, a mobile ground director station, and four Eglin Test Range drone control sites.

Each QF-104A was produced by removing all combat and fire control systems and subsystems, and the installation of radio receivers, transponder beacons, a telemetry transmitting system, an optical scoring system (consisting of five 16mm cameras), an electronic scoring system, a self-destruct system, a smoke generator, a field arrestor hook, and additional fuel tanks in the gun bay area to provide a further 100gal of internal fuel capacity. Range was further extended by the continued use of the F-104's wingtip tanks and optional 195gal pylon tanks. To permit manned ferry flights by personnel of the 3205th Drone Squadron (DS) a minimum of communications equipment was retained and an upward-firing Lockheed C-2 ejection seat replaced the original downward-firing seat.

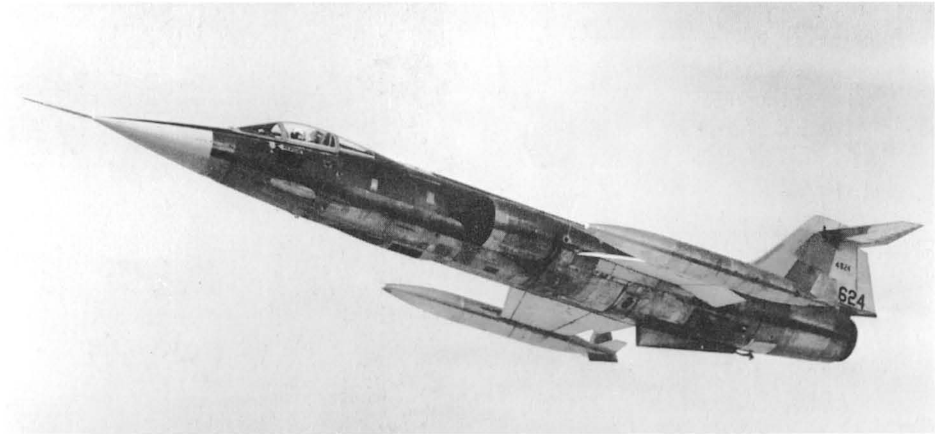
The first flight of a QF-104A drone occurred in late 1960. Operational use was marred by J79-GE-3A compressor stall problems, landing gear retraction problems and initially, severe tyre wear on landings. Operational support for the QF-104A drone programme was provided by the 3201st Maintenance Group (MG) and 3208th Test Group (TG). The final QF-104A drone operations were carried out in the early 1970s.

## JQF-104A

Designation temporarily applied to the QF-104A.

## RF-104A-LO (Model 383-93-04)

Designation applied to the unarmed photo-reconnaissance version of the single-seat F-104A which would have equipped four reconnaissance squadrons in Tactical Air Command had the design progressed to production. Design began in November 1954 and 19 RF-104A-LO models (56-939/956) were ordered by the US Air Force in 1955. However, in January 1957, before the start of production, all development work was cancelled and TAC decided instead to equip its reconnaissance squadrons with the McDonnell RF-101C Voodoo, which had a longer range and heavier load-carrying capability.



**61-2624, the first RF-104A-LO (Model 383-93-04) which was delivered to Greece under MAP, after Tactical Air Command decided, in January 1957, before the start of RF-104A production, to cancel an order for 18 of these unarmed photo-reconnaissance versions of the single-seat F-104A and instead equip its four reconnaissance squadrons with the RF-101C Voodoo, which had a longer range and heavier load-carrying capability.** Lockheed

## TF-104A-LO

Designation applied to the projected, and unbuilt, two-seat non-combat-capable (unarmed) trainer version of the single-seat F-104A, but which was not proceeded with as the US Air Force preferred the combat-capable two-seat F-104B.

## F-104B-LO (Model 283-93-03)

Two-seat, dual-control, combat trainer version of the F-104A. Although the USAF had ordered the Northrop T-38 Talon dedicated supersonic primary jet trainer in June 1956, this aircraft would not be available for some time so Lockheed's suggestion that its proposed tandem-sea derivative of the F-104A be used in the interim was accepted. On 2 March 1956 the USAF placed an initial order for six F-104B-1s (56-3719/3724), and on 4 December a contract for twenty additional production F-104Bs (F-104B-5; 57-1294/1302; F-104B-10: 57-1303/1311; F-104B-15: 57-1312-1313) was received by Lockheed.

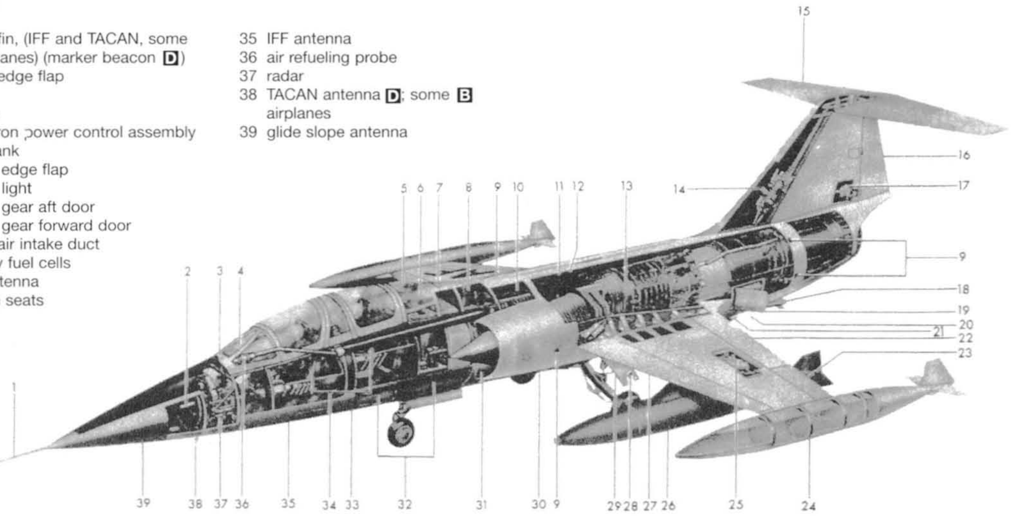
The first F-104B-1-LO was quite literally built by hand at Palmdale, California, using an F-104A airframe (c/n 283-5000/56-3719) built on the production line at Burbank. 56-3719 was transported by road to Edwards AFB for its first flight, on 16 January 1957. At first, the F-104B was classified as a service test aircraft and was therefore unofficially designated YF-104B. Later, this aircraft, which was used subsequently to test the downward-ejection seat initially fitted to all USAF Starfighters, was brought up to F-104B production standard.

The first production F-104B was delivered to the USAF in September 1957, the last F-104B-15-LO in November 1958. To provide space for the second seat, mounted aft beneath an extended canopy, the 20mm Vulcan cannon of the single seater was removed, some of the electronics were relocated, internal fuel capacity was reduced from USgal 897 to 752 (3,396 to 2,847l). The vertical stabilizer was increased in area by twenty-one per cent and it featured a power boost rudder. The nosewheel was re-positioned to the front of the landing gear well and retracted rearward (as used on the two XF-104s) instead of forward as on the F-104A. Provision for two underwing and two wingtip-mounted drop tanks was retained. Power was provided by a General Electric J79-GE-3A/3B engine of 9,600lb static thrust (4,354kg), and 14,800lb (6,713kg) with afterburner. The fin area was increased by 35 per cent and a fully powered rudder was adopted. Armament consisted of just two AIM-9B Sidewinder missiles with AN/ASG-14T-1 fire control system.

Four F-104Bs were given to the Republic of China Air Force (RoCAF) on Formosa (Taiwan), and eight were received by Jordan. In December 1959 one F-104B (53-1303) was given to NASA.

### GENERAL ARRANGEMENT F-104 B & D

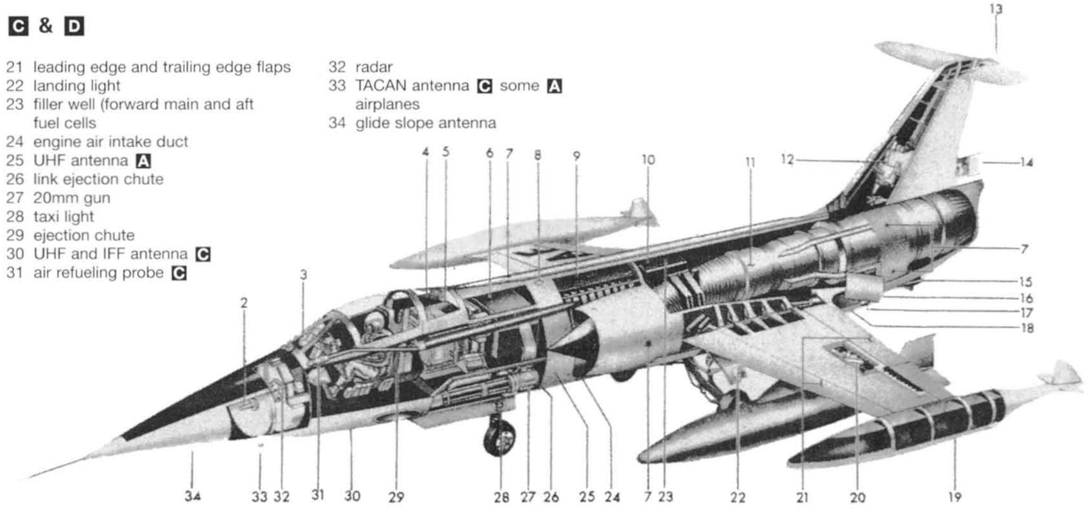
1 pitot static boom
2 radar antenna
3 infrared sight window
4 optical sight, infrared sight and camera
5 VOR antenna
6 electronics compartment
7 auxiliary fuel cell and filler well
8 air conditioning compartment
9 navigation lights
10 forward main fuel cell
11 aft fuel cells
12 internal fuel cells filler well
13 J79 engine and afterburner
14 horizontal stabilizer power control assembly
15 controllable horizontal stabilizer
16 rudder
17 rudder power control assembly
18 drag chute door
19 speed brake
20 arresting hook
21 ventral fin, (IFF and TACAN, some B airplanes) (marker beacon D)
22 trailing edge flap
23 aileron
24 tip tank
25 left aileron ,ower control assembly
26 pylon tank
27 leading edge flap
28 landing light
29 landing gear aft door
30 landing gear forward door
31 engine air intake duct
32 auxiliary fuel cells
33 UHF antenna
34 ejection seats
35 IFF antenna
36 air refueling probe
37 radar
38 TACAN antenna D; some B airplanes
39 glide slope antenna



**Note**
1 AF serials 57-1320 and subsequent D

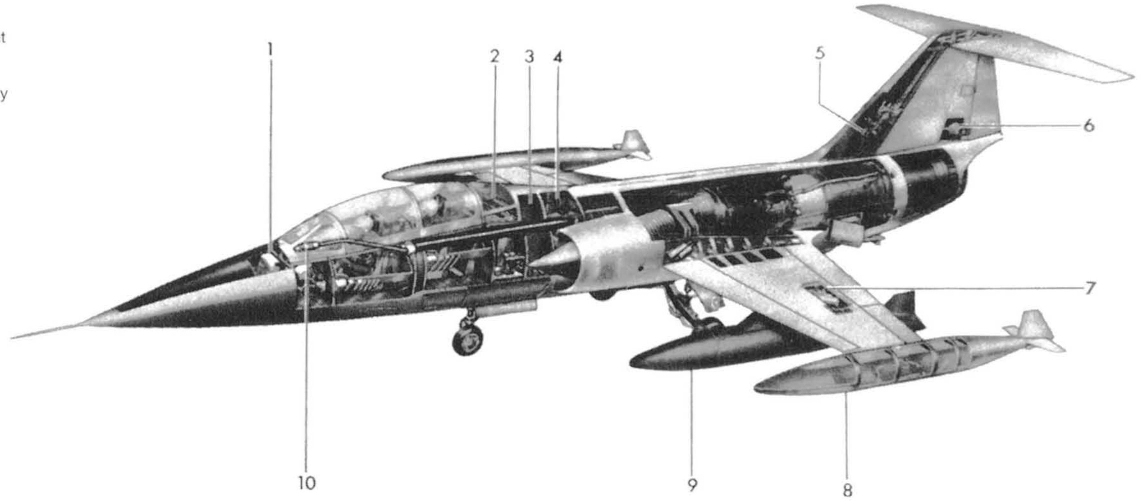
### GENERAL ARRANGEMENT F-104 C & D

1 pitot static boom
2 radar antenna
3 optical gunsight, infrared gunsight and camera
4 VOR antenna
5 electronics compartment
6 ammunition compartment
7 navigation lights
8 auxiliary fuel cell and filler well
9 forward main fuel cell
10 aft fuel cells
11 J79 engine and afterburner
12 horizontal stabilizer power control assembly
13 controllable horizontal stabilizer
14 yaw damper
15 drag chute door
16 speed brake
16 rudder
17 arresting hook
18 ventral fin, (IFF and TACAN, some A airplanes)
19 tip tank
20 left aileron power control assembly
21 leading edge and trailing edge flaps
22 landing light
23 filler well (forward main and aft fuel cells
24 engine air intake duct
25 UHF antenna A
26 link ejection chute
27 20mm gun
28 taxi light
29 ejection chute
30 UHF and IFF antenna C
31 air refueling probe C
32 radar
33 TACAN antenna C some A airplanes
34 glide slope antenna



### CUTAWAY VIEW OF F-104D.

1 radar
2 forward electronics compartment
3 aft electronics compartment
4 air-conditioning package
5 stabilizer power control assembly
6 rudder power control assembly
7 aileron power control assembly
8 tip tank
9 pylon tank
10 aerial refuelling probe



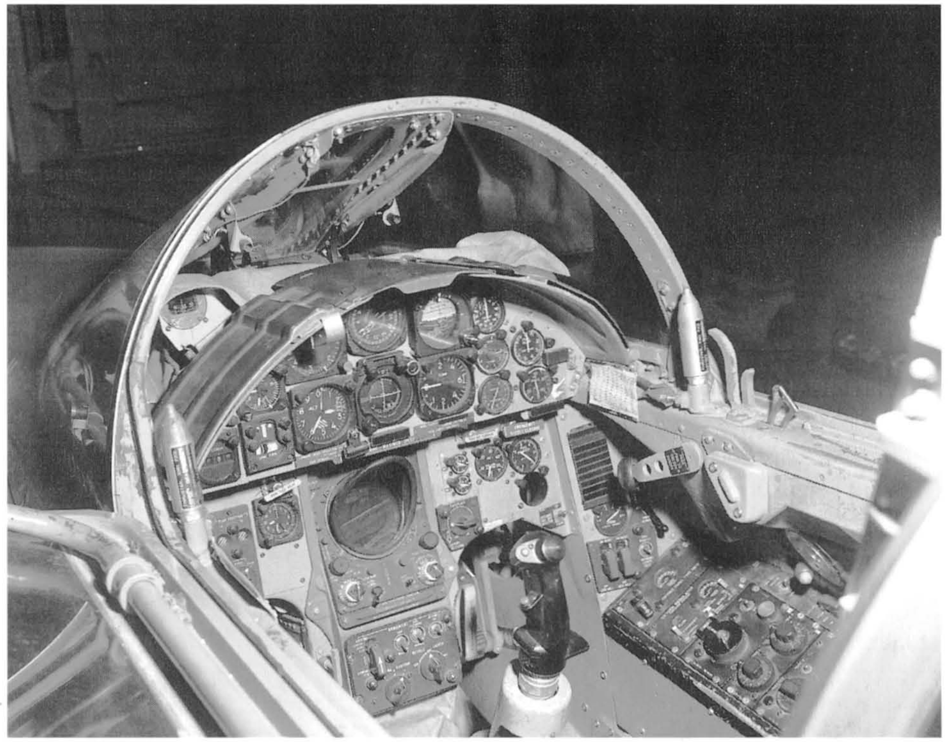
all pictures courtesy Lockheed

## F-104C-LO (Model 483-04-05)

A total of 77 F-104Cs (56 F-104C-5s 56-883/938, and 21 F-14C-10s, 57-910/930) all-weather, fighter-bomber variants was ordered by Tactical Air Command. The first F-104C flew on 24 July 1958 and the first example was accepted by Tactical Air Command on 15 October 1958 during the annual USAF Fighter Weapons Meet at Nellis AFB, Nevada. The last F-104C was delivered in June 1959.

The F-104C differed from previous versions in having the possibility to refuel in flight using a removable in-flight-refuelling probe fitted on the port side of the fuselage. The F-104C was also fitted with the all-up AN/ASG-14T-2 fire control system, and had the ability to carry a single nuclear store (either a Mk-28 nuclear bomb or a Douglas AIR-2 Genie air-to-air rocket). Initially, power was provided by a new General Electric J79-GE-7 engine of 10,000lb static thrust (4,536kg), and 15,800lb (7,167kg) with afterburner. By early 1963 operational problems – not least caused by the troublesome J79-GE-7A engine – had led to forty serious incidents which resulted in the deaths of nine pilots and the loss of 24 aircraft; all in a period of less than five years. As a result, Project *Seven Up*, a General Electric modification programme on its 7A turbojet, began in May 1963 and ended in June 1964.

Early in 1963 the USAF initiated Project *Grindstone* whereby Lockheed were to modify all remaining F-104Cs so that in addition to the 20mm cannon and two wingtip-mounted AIM-9 Sidewinders, the aircraft could carry two more Sidewinders beneath the fuselage, or bombs and unguided HE 2.75in diameter rockets in pods on underwing and fuselage stations. Tactical Air Command phased out the last of its F-104Cs in 1967.



**F-104C instrument panel. Dubbed the 'peek and panic' panel by Lockheed engineers and test pilots, the instrument panel was designed for easy-to-read simplicity, with eleven separate windows centralized in one location for instant recognition of trouble. The main panel includes flight attitude indicators and navigation instruments, tachometer and gauges for exhaust temperature, jet nozzle position and fuel. At each side is a fire, or overheat, warning light that came on if engine or tail sections had critical temperatures. If engine inlet air temperatures exceeded specified limits, a 'slow' warning light would illuminate on the left side of the panel. Another main panel indicator was for temperature and pitch rate. The T-shaped lower panel held the radar indicator, hydraulic and engine oil pressure gauges, fuel flow, and cabin altitude indicators. Non instruments mounted there were the armament control panel, landing gear and flap position units. There was also a drag chute manual release pull handle, gunsight controls, pilot faceplate heat control, hydraulic pressure gauge system selector switch and the armament control section. The bullet-shaped protuberances left and right of the canopy sill, just in front of the windscreen frame are the canopy thrusters (the canopy jettison handle is located behind the stick). Right console sub-panels are for oxygen control, navigation, bombing control, UHF and circuit breakers. Carried on the aluminium alloy seat was an automatic survival kit that included disconnect hardware, automatic life raft inflation, high-pressure emergency oxygen bottles with fifteen minutes' duration, and a regulator suitable for partial pressure suits above 42,000ft (12,800m).** Lockheed

## F-104D-LO (Model 383-04-06)

Designation applied to 21 two-seat combat trainer versions (F-104D-5; 57-1314/1320; F-104D-10; 57-1321/1328; F-104D-15; 57-1329.1334) delivered to Tactical Air Command from November 1958 to September 1959. The F-104D combined the cockpit layout of the F-104B with the armament, engine and flight-refuelling capability of the F-104C. Like the B model, it incorporated the larger area vertical fin and its nose landing gear retracted rearward like the F-104B's. The first F-104D example was flight tested on 31 October 1958.

## F-104DJ (Model 583B-10-17)

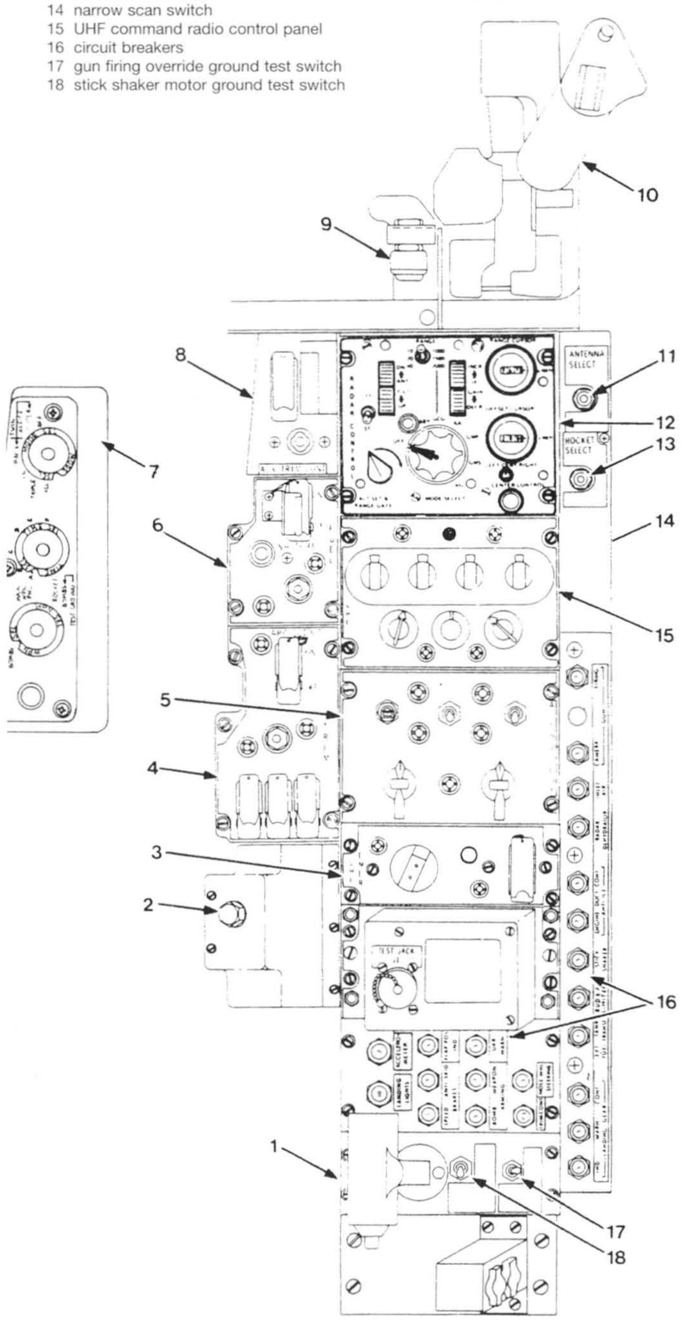
Designation applied to 20 two-seat trainers almost identical to the F-104D (the F-104DJ had a Japanese-built engine and upward-firing ejection seat). The first F-104DJ was assembled by Lockheed-Burbank, and the remaining 19 were reassembled in Japan by Mitsubishi (fuselage and final assembly) and Kawasaki (main wing, tail and nose section) between July 1962 and January 1964 for the *Nihon Koku Jieitai* (Japanese Air Self-Defence Force/JASDF). Electronics and other items were compatible with those of the F-104J version. Power was provided by the J79-1H1-11A engine of 10,000lb static thrust (4,536kg), and 15,800lb (7,167kg) with afterburner which was built under licence by Ishikawajima-Harima.

LEFT CONSOLE AND SIDE WALL

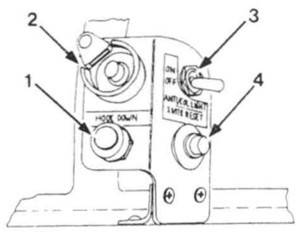
1 spot light
2 anti-g valve
3 emergency UHF control panel
4 stability control panel
5 automatic pilot control panel
6 fuel control panel
7 sub weapon panel
8 trim control panel
9 wing flap lever
10 throttle
11 antenna select switch
12 radar control panel
13 rocket select switch
14 narrow scan switch
15 UHF command radio control panel
16 circuit breakers
17 gun firing override ground test switch
18 stick shaker motor ground test switch

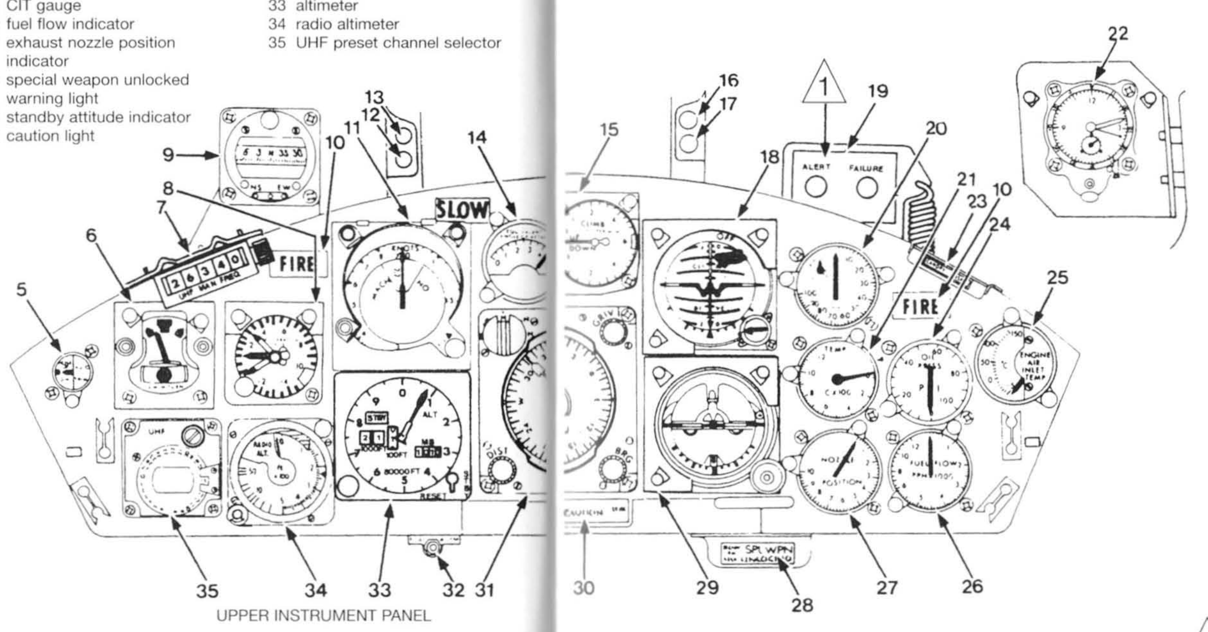
UPPER INSTRUMENT PANEL

1 arresting hook release light
2 arresting hook release button
3 anti-collision light switch
4 radar transmitter reset button
5 pitch trim indicator
6 turn and slip indicator
7 UHF remote frequency indicator
8 accelerometer
9 standby compass
10 fire warning light (2)
11 airspeed and mach number indicator
12 IFF warning light (INOP)
13 radar lock-on light
14 APC indicator
15 vertical velocity indicator
16 bomb release light
17 radio altimeter warning light
18 MM-3 altitude indicator
19 EL-70 panel or EL-70/EL-73 panel
20 tachometer
21 EGT gauge
22 clock
23 canopy unsafe warning light
24 oil pressure gauge
25 CIT gauge
26 fuel flow indicator
27 exhaust nozzle position indicator
28 special weapon unlocked warning light
29 standby attitude indicator
30 caution light
31 PHI navigation system indicator
32 flap asymmetry warning light
33 altimeter
34 radio altimeter
35 UHF preset channel selector

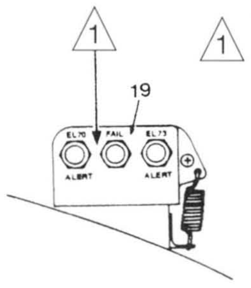


LEFT CONSOLE



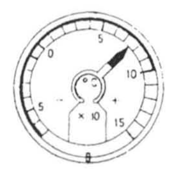


UPPER INSTRUMENT PANEL

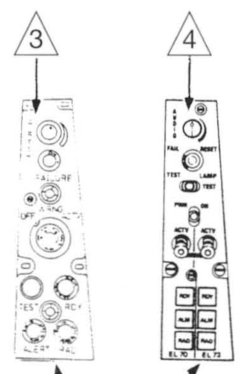


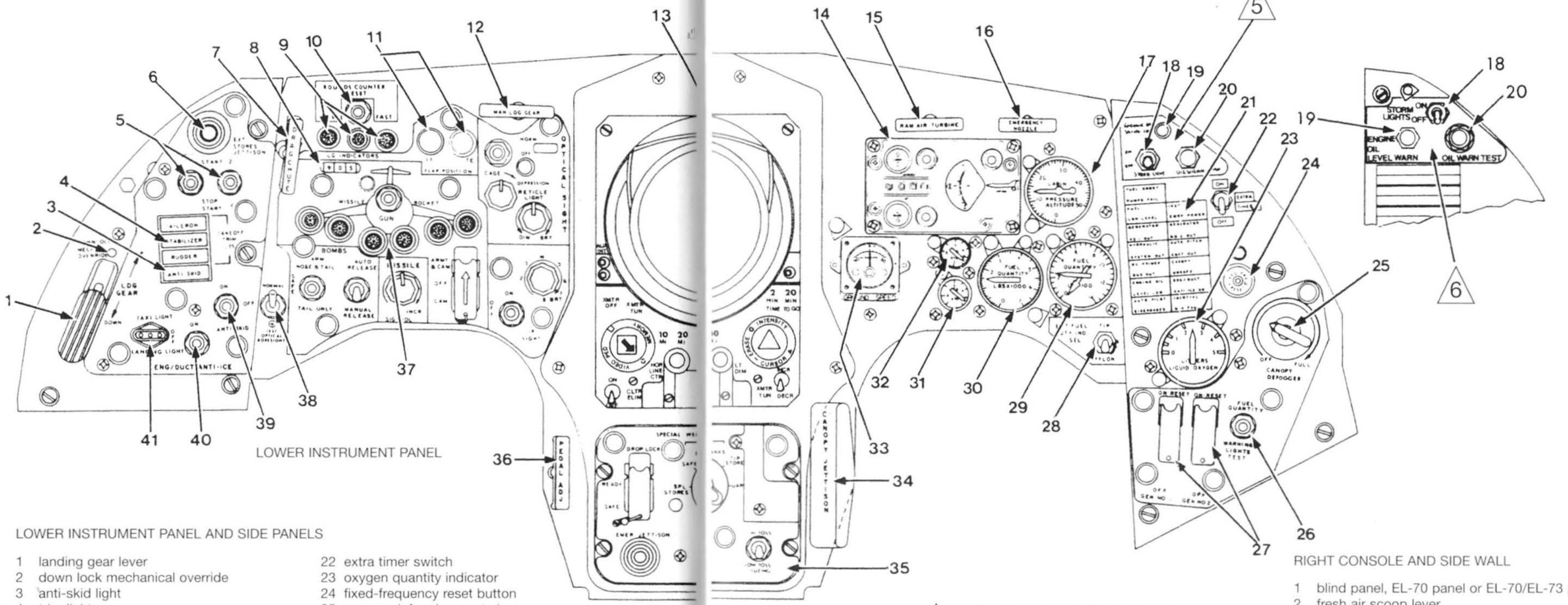
1 EL-70 and EL-70/EL-73 panels are shown in operational condition. If aircraft is equipped with provisions only, the panels are folded down out of view.

EL-70/EL-73 panel may be installed in lieu of EL-70 panel



CIT gauge shown above may be installed in some aircraft





LOWER INSTRUMENT PANEL

LOWER INSTRUMENT PANEL AND SIDE PANELS

1 landing gear lever
2 down lock mechanical override
3 anti-skid light
4 trim lights
5 start switches
6 external stores jettison button
7 chute handle
8 ammunition rounds counter
9 landing gear position indicator
10 ammunition rounds counter reset switch
11 wing flaps position indicator
12 manual landing gear release handle
13 radar indicator
14 clearance plane and antenna tilt indicator
15 rat extension handle
16 emergency nozzle closure handle
17 cabin altimeter
18 storm light switch
19 engine oil level warning light
20 oil warning test button
21 warning lights panel
22 extra timer switch
23 oxygen quantity indicator
24 fixed-frequency reset button
25 canopy defogging control
26 fuel quantity system test switch
27 generator switches
28 external fuel quantity indicator selector switch
29 external fuel quantity indicator
30 internal fuel quantity indicator
31 no. 2 hydraulic pressure gauge
32 no. 1 hydraulic pressure gauge
33 ground speed error indicator
34 canopy jettison handle
35 special weapons/weapons selector panel
36 rudder pedal adjustment handle
37 armament control panel
38 optical boresight test switch
39 anti-skid switch
40 engine duct anti-ice switch
41 landing/taxi light switch

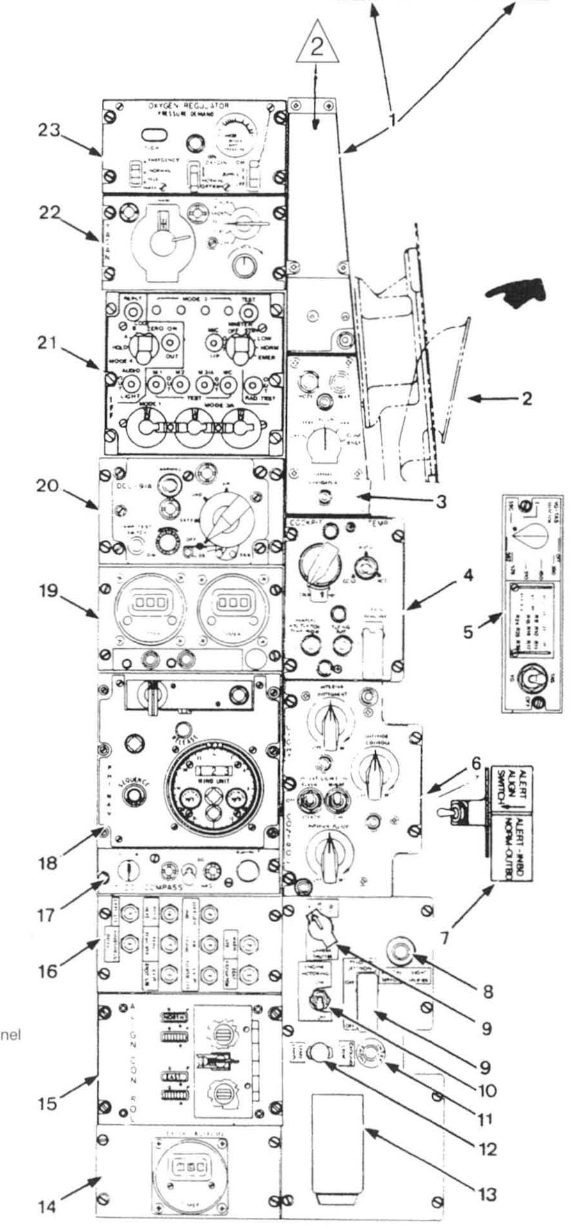
2 Aircraft equipped with EL-70 and EL-70/EL-73 (provisions only)

3 Aircraft equipped with EL-70 in operational condition

4 Aircraft equipped with EL-70/EL-73 in operational condition

5 TA-FI 1468 not complied with

6 TA-FI 1468 complied with



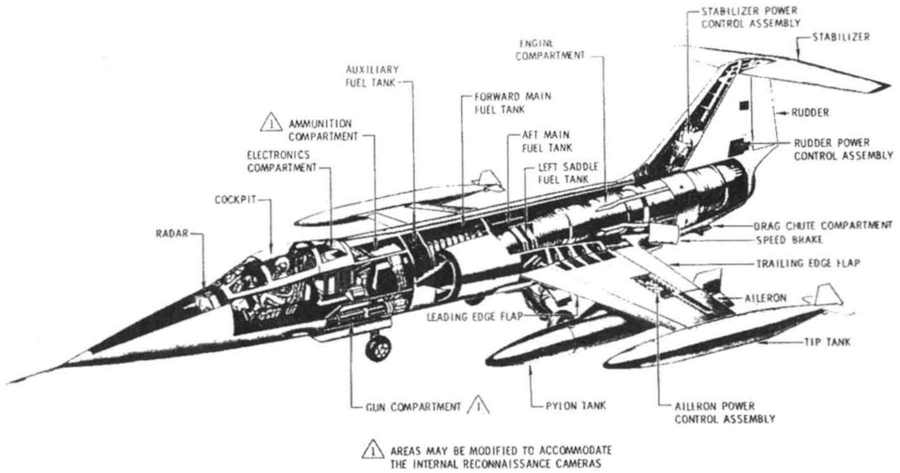
RIGHT CONSOLE

RIGHT CONSOLE AND SIDE WALL

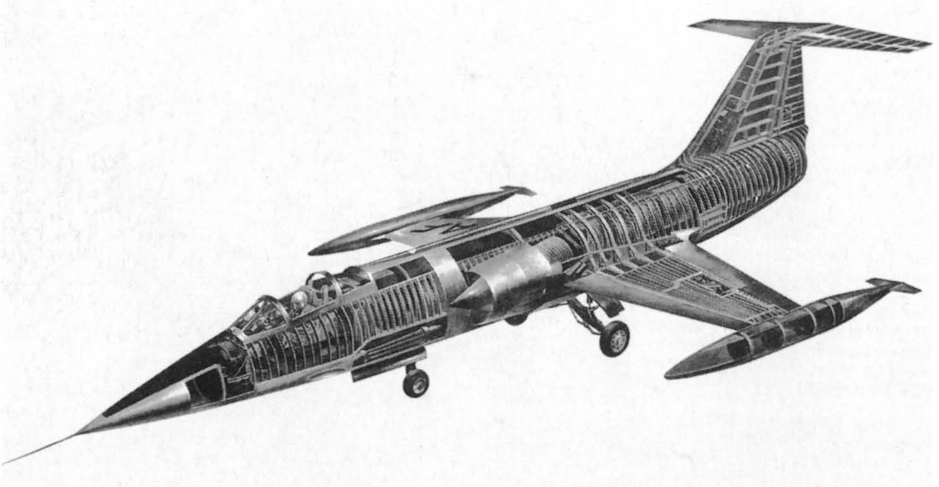
1 blind panel, EL-70 panel or EL-70/EL-73 panel
2 fresh air scoop lever
3 inertial navigator control panel
4 heating control panel
5 VG-TAS selector panel
6 lighting control panel
7 alert align switch
8 optical sight servoamplifier test button
9 camera shutter selector switch
10 pylon jettison switch
11 engine motoring switch
12 ground crew interphone button
13 spare lamps
14 light assembly
15 extra timer
16 align control (IN) panel
17 circuit breakers
18 C-2G compass control panel
19 PHI navigation control panel
20 dual timer panel
21 DCU-9A special stores monitor panel
22 IFF control panel
23 TACAN control panel
24 oxygen control panel

**Cockpit layout.**

**F-104F BB+365 (WerkNr.5052) of the** Luftwaffe. **This aircraft was built in 1960 and was shipped to Bremerhaven and then despatched by train to Nörvenich and issued to** WaSLw.10. **This aircraft was one of the four F-104Fs (the others were BB+370, BB+385, and BB+387) from the same formation which were all lost on 19 June 1962. The pilot of BB+365, Staffelkapitän Olt. Bernd Kuebart, was killed, as were the other three pilots, including Captain Jon Speer USAF.** *Aeroplane*



***(Above and below)*** **Cutaway view of F-104G.** Lockheed



## F-104E

Designation not assigned.

## F-104F-LO (Model 483-04-08)

Designation applied to thirty two-seat trainers identical to the F-104Ds produced by Lockheed for the Federal Republic of Germany. Deliveries began at the start of October 1959 when they were temporarily serialled 59-4994/5023 (later being assigned German codes BB360/BB389 and lastly, after 1 January 1968, 2901/2930). They were all withdrawn from use in December 1971.

## F-104G-LO (Model 683-10-19)

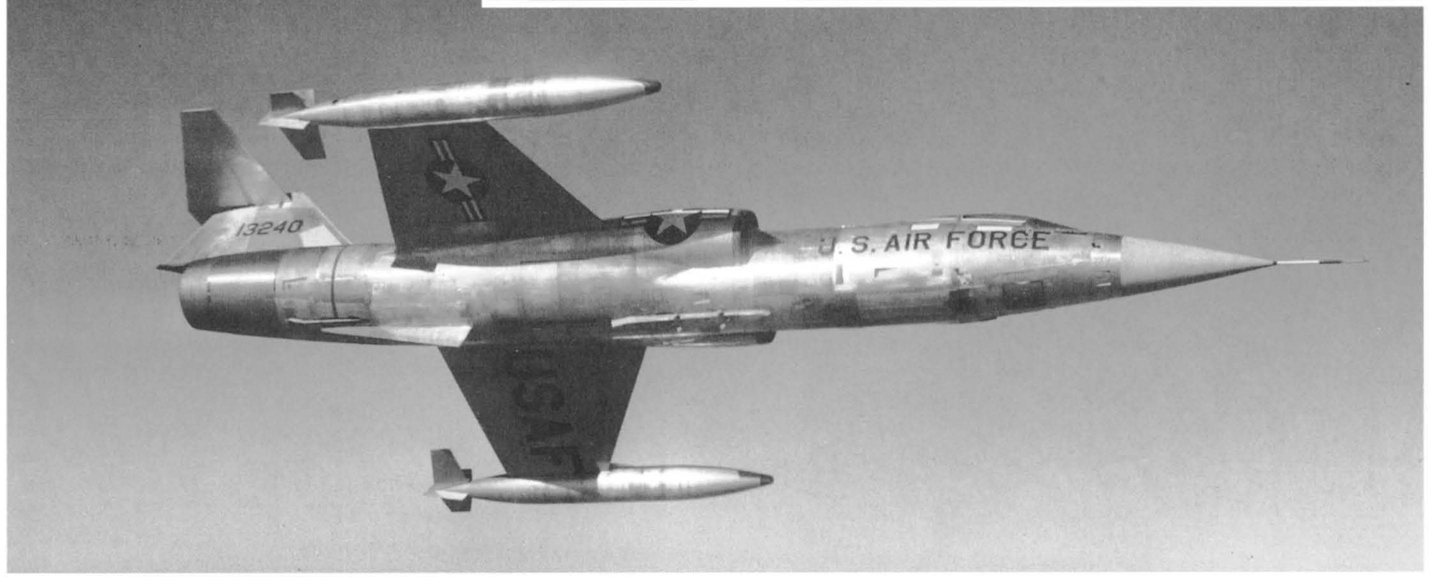
A total of 1,127 multi-role, all-weather fighter versions for NATO, built by MBB, Fokker-Aviolandia, SABCA-Fairey, Fiat and Canadair. All were delivered from 1960 to 1973. The F-104G differed from the F-104C principally in having a reinforced structure, larger tail surface area with fully powered rudder as used on the two-seater Starfighter, combat manoeuvring flaps, vastly improved electronics centred around the Autonetics F15A NASARR, and a larger capacity for weapons loads.

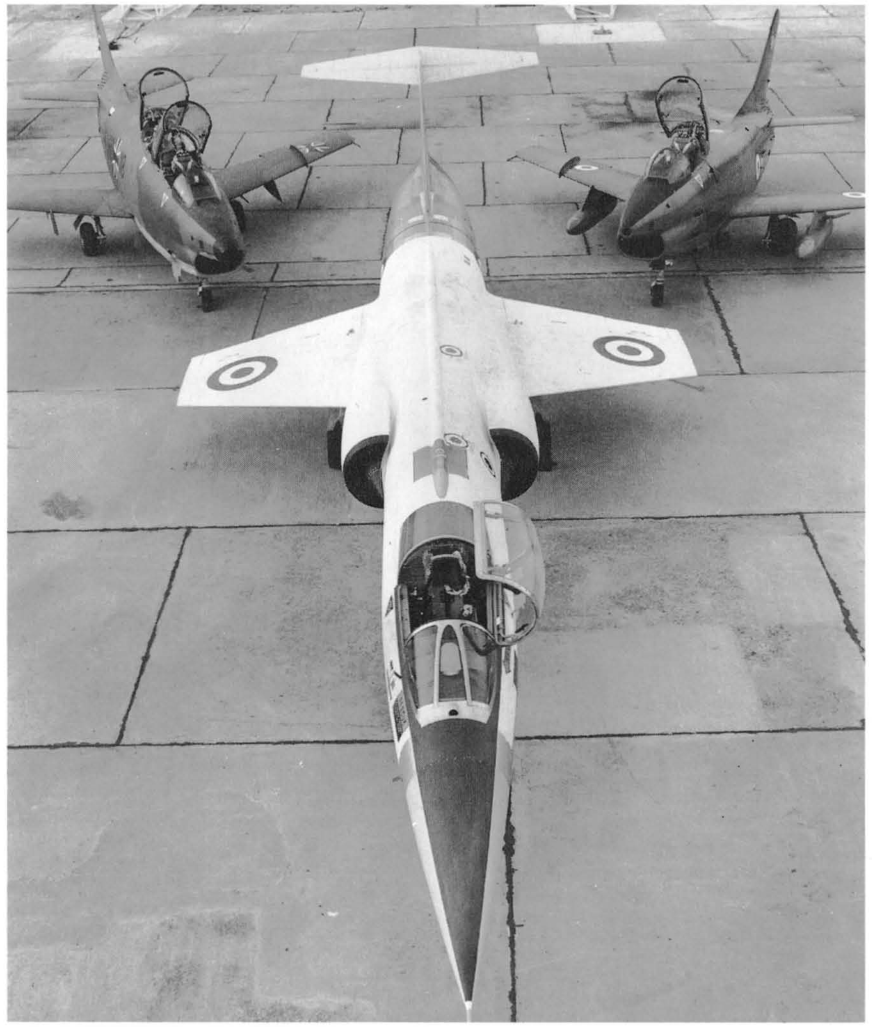
The Lockheed Model C-2 upward-firing ejection seat fitted at the time of delivery was, beginning in 1967, gradually phased out in favour of the Martin-Baker Mk.GQ7(F) 'zero-zero' seat. While the F-104G retained the Vulcan cannon of the earlier versions, it had additional attachments to take up to four Sidewinder missiles, as well as the NASARR system to provide radar search, acquisition and automatic tracking for lead-collision or lead-pursuit

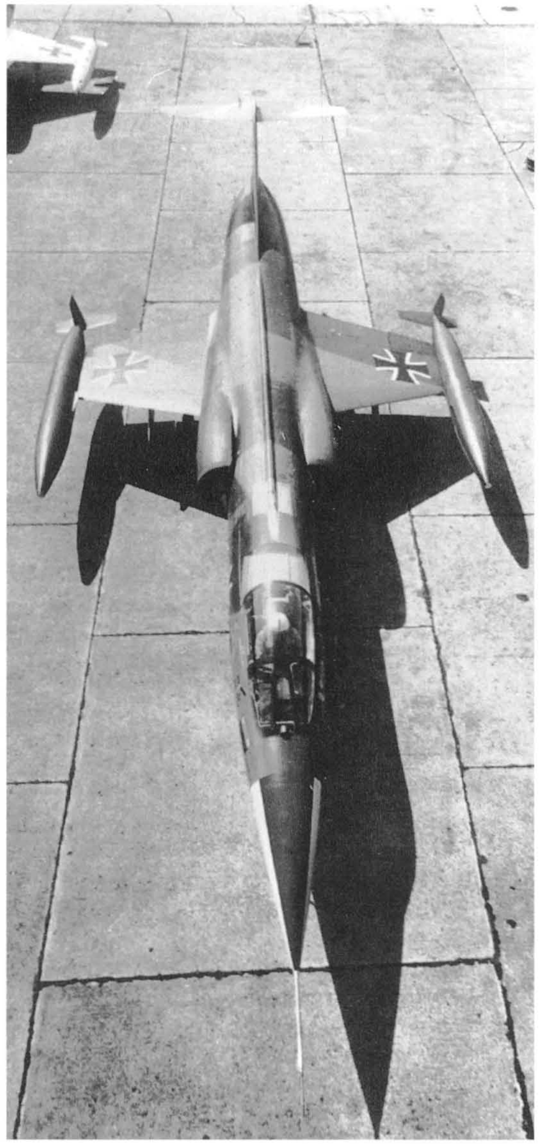
***(Above)*** **Lockheed-built F-104G with four 750lb (340kg) M117 bombs on the four underwing pylons and a fuel tank on the aircraft centreline.** Lockheed

***(Right)*** **F-104G Starfighters under construction at Augsburg.** DaimlerChrysler Aerospace

**F-104G 63-13240 built for the** Luftwaffe. Lockheed



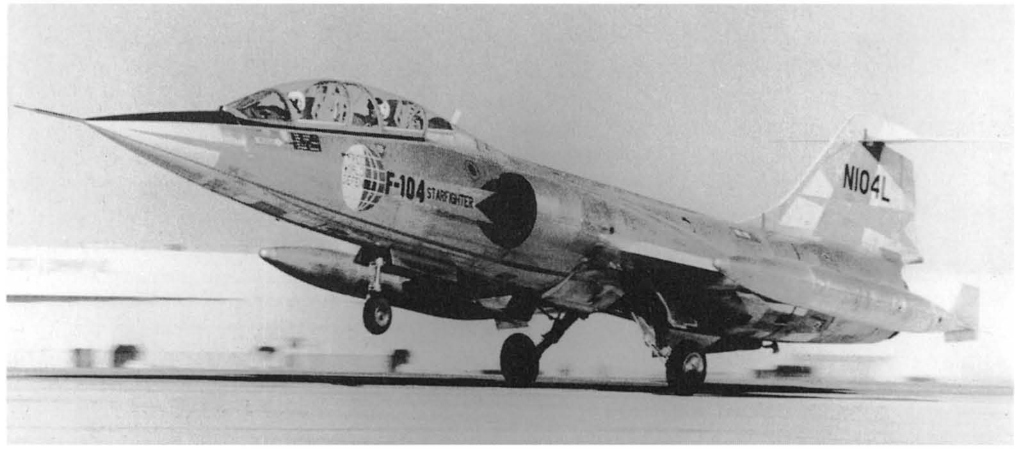




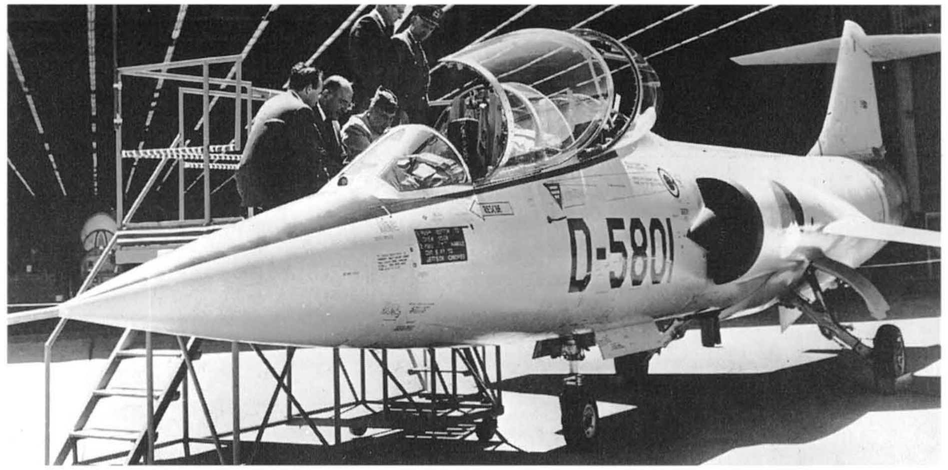
*(Above)* 683-400 (MM6501) the first Military Assistance Program (MAP) F-104G built by Lockheed and which was completed on 10 August 1962, pictured with a Fiat G91 T/3 and G.91R. This Starfighter served as the pattern aircraft for Fiat of Italy. The darkened intake lips are heating elements unique to MAP variants of the F-104G. Lockheed

*(Above right)* F-104G of the Luftwaffe. The G model differed from the earlier F-104C in many respects, most notably in having the larger vertical tail used on the F-104B/D, a much strengthened airframe for low-level operation, an improved F-15A NASARR fire control system, all-weather avionics, two additional underwing weapons pylons and a more reliable J79-GE-11A engine. Full span combat manoeuvring flaps were added to the wing leading edge to improve manoeuvrability and the main landing gear wheels and tyres were enlarged to carry the additional all-up weight. Bundesministerium

N104L, the Lockheed-owned TF-104G (Model 583D) accelerating toward take-off speed at Palmdale, California, to begin one of a series of demonstration flights. After use as a company demonstrator N104L was used by Jacqueline Cochran who in June 1964 set three women's speed records; 1,429.246mph (2,300.14km/h) over a 15/25km course; 1,303.18mph (2,097.23km/h) over a 100km (62 miles) closed circuit; and 1,127.4mph (1,814.34km/h) over a 500km (310 miles) course. In May N104L was delivered to the Koninklijke Luchtmacht (KLu, Royal Netherlands Air Force) with the Dutch serial, D-5702. It was acquired by Turkey on 25 August 1980 as 5702. Lockheed



TF-104G D-5801, the first two-seat Starfighter for the Royal Netherlands Air Force (KLu), is inspected by representatives of Lockheed and the RNLAF soon after completion at Palmdale, California, in July 1963. D-5801 was acquired by Turkey on 8 March 1984. *Aeroplane*



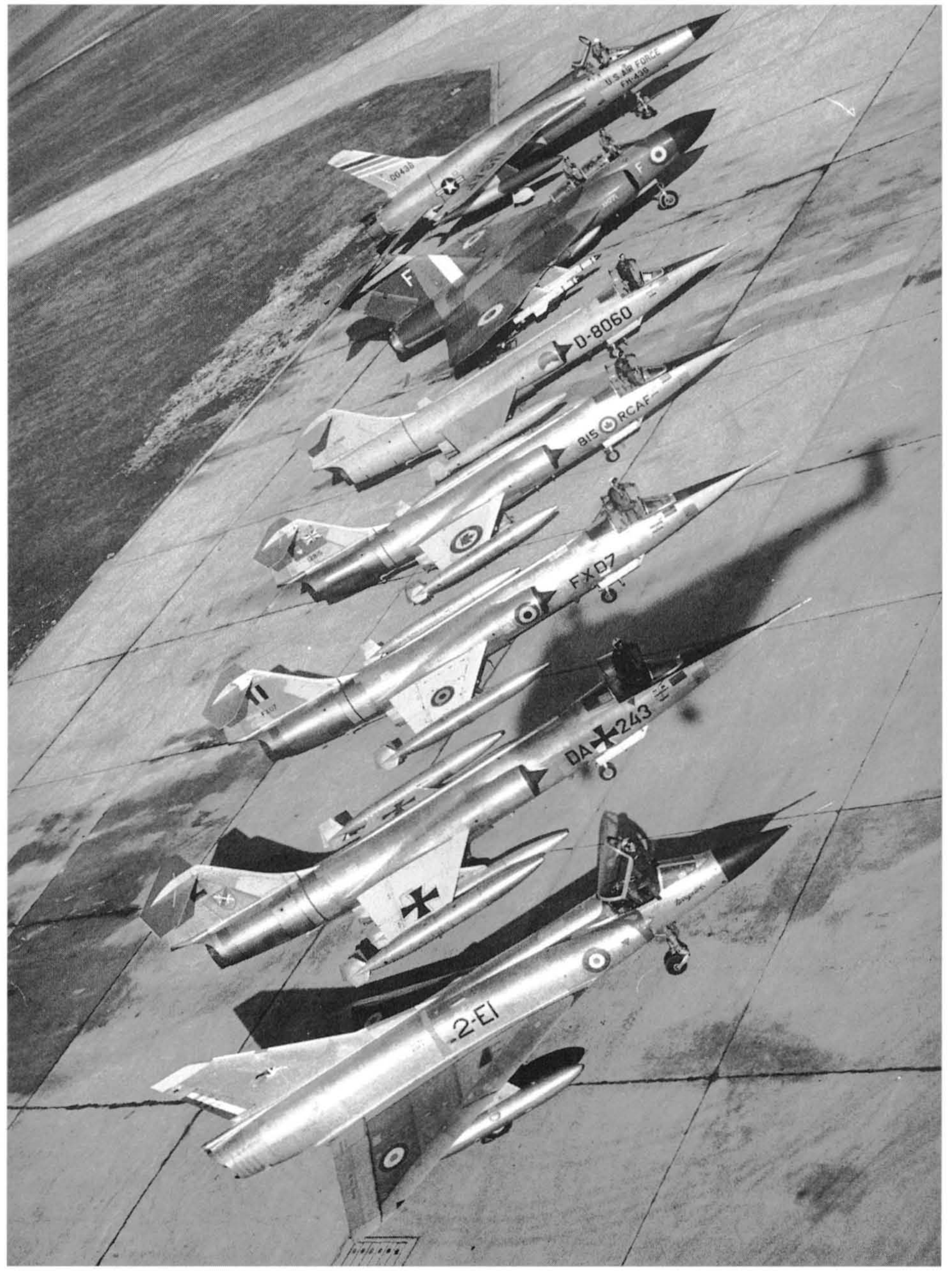
attack with missiles. A director-type gunsight was used for the cannon, giving optical indication of line of sight, with the lead angle furnished by the Autonetics F15A NASARR computer. The bombing computer was linked with the inertial navigator, the air-data computer and the NASARR fire control system.

The first F-104G, a Lockheed-built model (c/n 683-2001) was flown on 7 June 1960. The first Canadair-built 'G' flew in July 1963. The Canadian-built F-104G model differed from those manufactured in Europe, principally in having the F-15AM-11 NASARR which was optimized for both the air-to-air and air-to-ground roles. Power was provided by a General Electric J79-GE-11 engine of 10,000lb static thrust (4,536kg), and 15,800lb (7,167kg) with afterburner. European-built aircraft were fitted with engines co-produced under licence by MAN-Turbo in Germany, the *Fabrique Nationale* in Belgium, and Fiat in Italy. Most *Luftwaffe* and *Bundesmarine* F-104Gs were later retrofitted with the updated, German-built J79-MTU-JIK engine. The 1,127th and last F-104G was delivered by MBB in 1973.

## RF-104G-LO (Model 683-04-10)

Designation applied to 189 tactical photo-reconnaissance versions almost identical to the F-104G except for the removal of guns and the adoption of photographic equipment. Lockheed built forty RF-104Gs

Line up of Starfighters for NATO nations, together with jet fighters of RAF Germany, USAF, and France. From top: USAF F-105D Thunderchief 00436 of the 36th Tactical Fighter Wing at Bitburg, Germany; RAF Gloster Javelin FAW.7 XH771/F; Koninklijke Luchtmacht (KLu, Royal Netherlands Air Force) F-104G D-8060 (which was acquired by the Türk Hava Kuvvetleri (THK, Turkish Air Force) in January 1982); RCAF CF-104 12815; Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu) FX-07 (which was acquired from the Belgian Air Force by the RoCAF (Taiwan) in 1990); Luftwaffe F-104G DA+243 and French Armée de l'Air Mirage IIIE 2-EI. NATO



**F-104G KG-101 (8001), the first Fokker-built Starfighter for the** Luftwaffe**. It first flew on 11 November 1961 and it was issued to** JaboG31 **on 10 May 1962. It finished its days as a ABDR at Faberg.** KLu

***(Left)*** **Mr A.P. 'Jos' Moll, Fokker chief test pilot, climbs aboard KG-101 on 11 November 1961 for the first flight of the first F-104G to be assembled by Fokker. The first thirty aircraft were built using Lockheed-made components, the rest were wholly North-group built.** *Aeroplane*

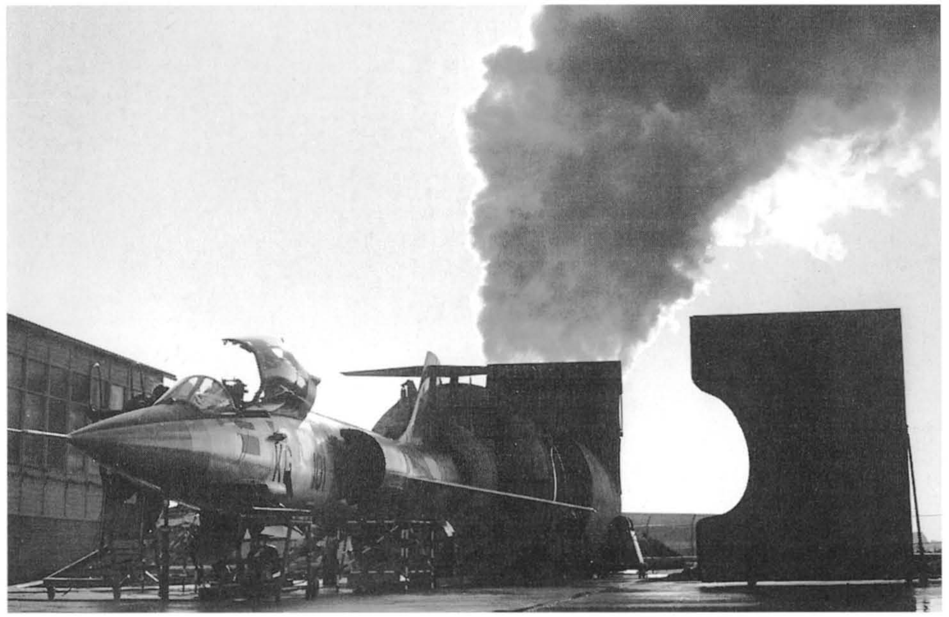
(61-2624/2633; 62-12232/12261); the North Group (Fokker) 119 (67-14891-?) and the Italian Group (Fiat-Aeritalia) thirty. The aircraft for the *KLu* (Royal Netherlands Air Force) had an external ventral camera pack, while the majority of the others carried three KS-67A cameras in the forward fuselage. In both cases the M61 cannon and its 725-round magazine aft of the cockpit were removed to make room. Many RF-104Gs were subsequently modified to F-104G standard.

## RF-104G SLAR (Sideways-looking Radar)

A Fokker-built RF-104G (8222) was modified to carry a Goodyear 102R nose-mounted sideways-looking radar (SLAR) system in a programme which entered the design stage in June 1966. It was actually a follow-on to an earlier programme involving a SLAR installed in an external centreline pod. The test aircraft carried the *Luftwaffe* number EB+121. The most noticeable exterior changes were the long radome which was extended to house the 6ft (1.8m) long SLAR antenna, and the Data Link antenna mounted just forward of the nose landing gear doors. The flight test aircraft also contained an external centreline pod to accommodate flight test instrumentation.

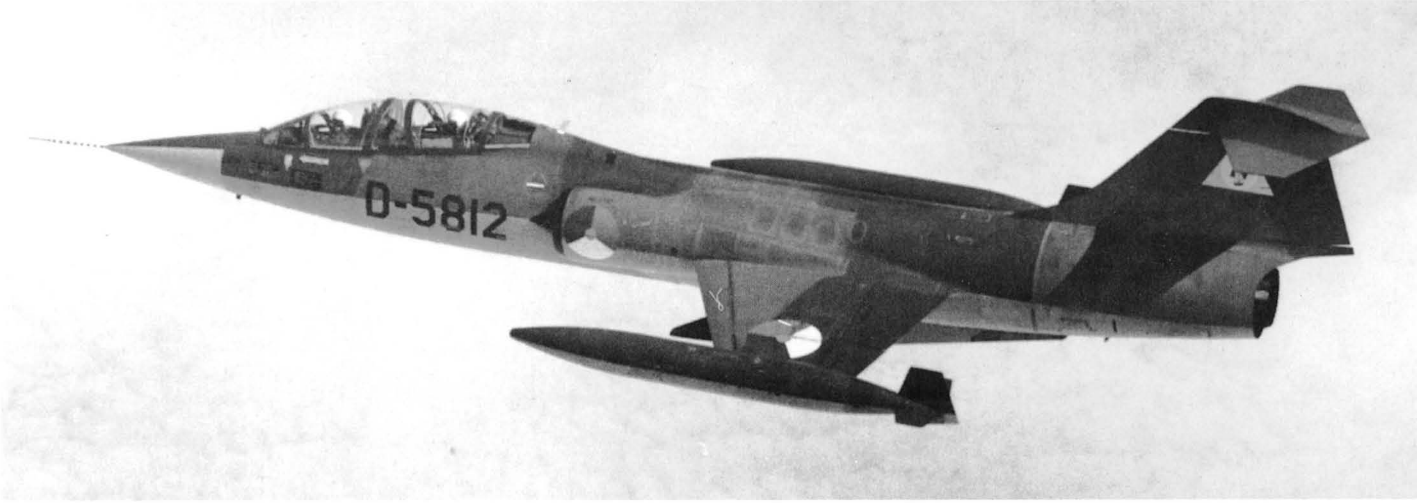
Internally, the Vulcan cannon and drum were removed and SLAR major electric components were installed in the vacated gun bay. These included an Amplifier/ Modulator, a Frequency Converter/Transmitter and the system Junction Box unit. The system contained a large recorder with 9.5in film which replaced all space previously occupied by the ammunition for the Vulcan cannon. Additional ancillary systems installed included a Kearfott Trackkeeper System for providing straight ground tracks and steering information to the SLAR, a Fairchild-Hiller Annotation Unit which encoded information concerning time and aircraft flight data for placement on the radar film, and an additional refrigeration package for cooling new system

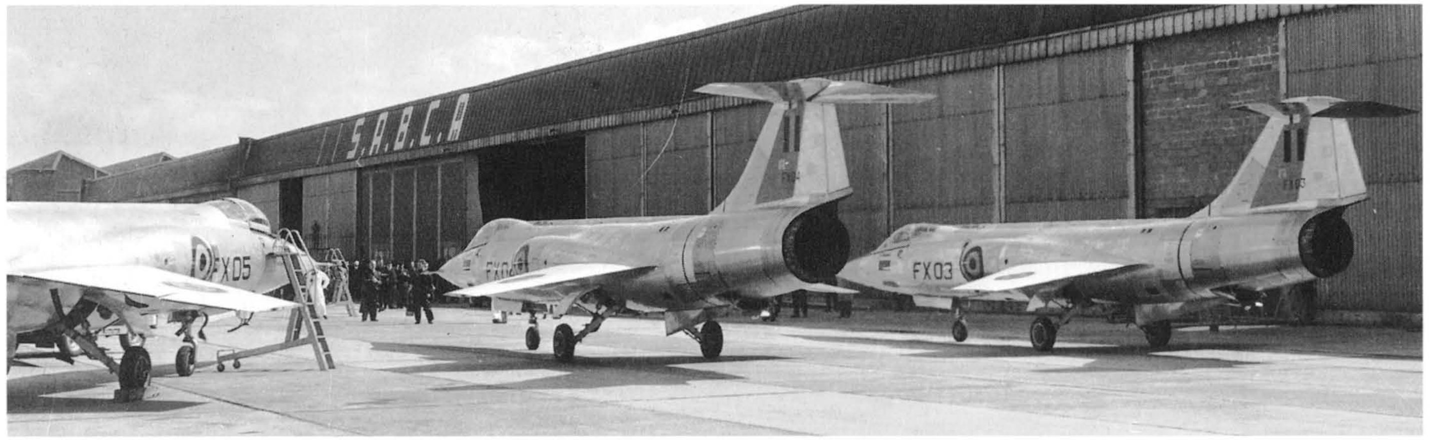
**F-104G KG-101 (8001) undergoing engine testing at the Fokker plant at Schiphol.** *KLu*



***(Below)*** **F-104G of the** Koninklijke Luchtmacht **(KLu, Royal Netherlands Air Force). This aircraft was acquired by** Türk Hava Kuvvetleri **(THK, Turkish Air Force) in January 1982.** via Philip Jarrett

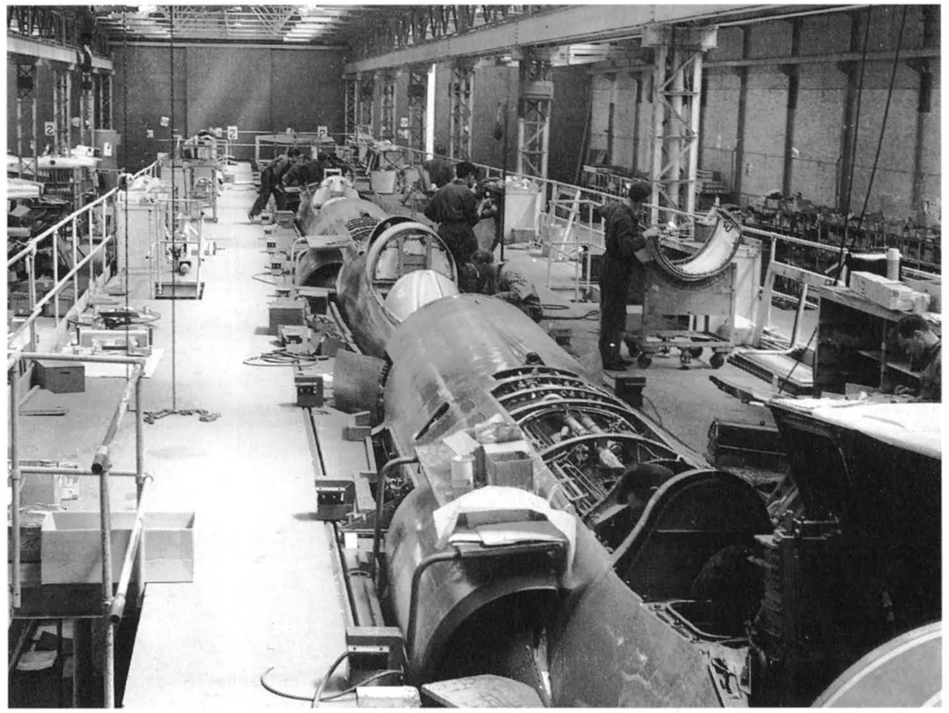
***(Bottom)*** **TF-104G D-5812 of the Operational Conversion Unit 'The Dutch Masters' at Twenthe AB, one of eighteen built by Lockheed for the** Koninklijke Luchtmacht **(KLu, Royal Netherlands Air Force). this aircraft was acquired by the** Türk Hava Kuvvetleri **(THK, Turkish Air Force) in February 1982.** *KLu*





*(Above)* **F-104G aircraft FX-05, FX-04 and FX-03 for the** Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu) **being rolled out at the SABCA plant. FX-05 was taken on charge at Gosselies on 21 May 1963 and issued to** 350ème **of 1 Wing. It was lost on 20 June 1968 after a power loss. Cdt H. Van Der Gaer (wing Ops), ejected safely. FX-04 was taken on charge at Gosselies in April 1963 and issued to** 350ème **of 1 Wing at Beauvechain. It was very badly damaged on 13 July 1976 at Kleine Brogel following an engine bay fire and was subsequently used as a loading training aircraft at 10th Wing. FX-03 was taken on charge at Gosselies on 3 April 1963 and issued to** 350ème **of 1 Wing at Beauvechain. It suffered an in-flight fire on 27 March 1975 but the pilot, Slt M. Lemoine, managed to put the aircraft down safely. It suffered a lightning strike on 9 June 1977. On 3 November 1981 FX-03 was flown to Koksijde for storage and withdrawn from use.** *Aeroplane*

**TF-104Gs 12664 and 12667 (two of the four CF-104Ds built by Lockheed for the RCAF). During winter 1973/84 Iskv334 of the** Kongelige Norske Luftforsvaret **(KNL, Royal Norwegian Air Force) reformed on the Starfighter with eighteen ex-Canadian Armed Forces CF-104s, and four CF-104Ds which were built by Lockheed for the RCAF June 1962–November 1963.** *Aeroplane*



**Fairey SA F-104G production line at Gosselies, Belgium.** Fairey SA

components. The Trackkeeper Indicator replaced the fire control radar scope in the cockpit. All of these components took up the space flight test normally reserved for flight test instrumentation components, thus the centreline pod as added.

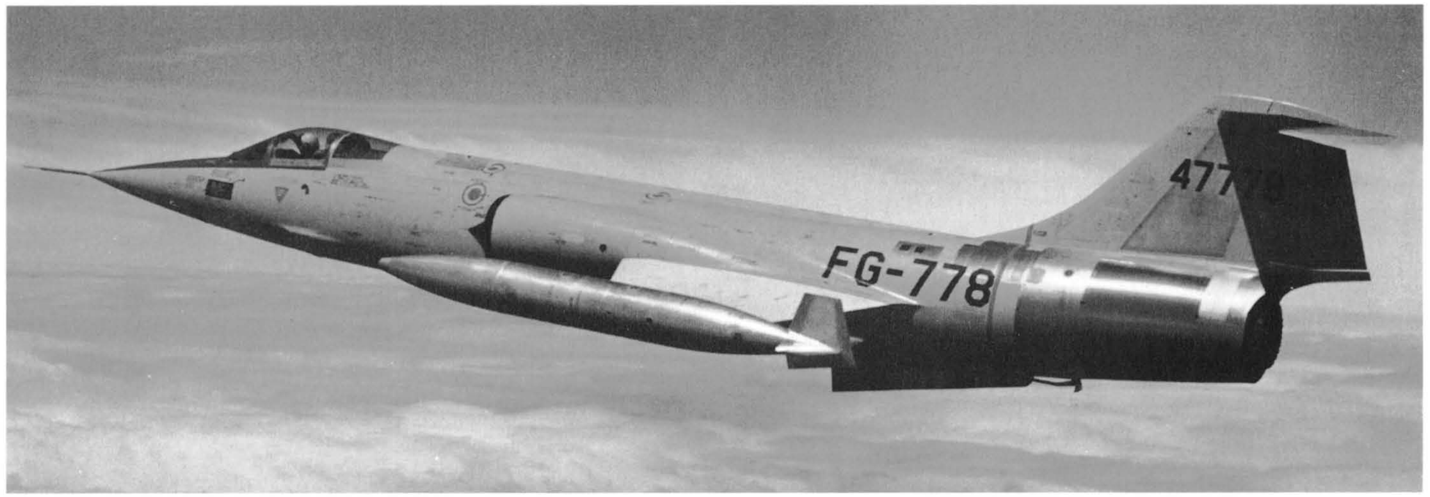
A major set of components of the system which were not installed in the aircraft were contained in the supporting mobile Ground Station. This consisted of two German Army five-ton truck chassis containing a receiving, dish antenna and pedestal for the data link system, data link electronics, processing and signal conditioning equipment, and a Correlator/Processor which processed the downlink data into a duplicate of the inflight recorded film, about 7–10 minutes behind real-time.

In order to evaluate this SLAR system, two ranges containing a variety of corner reflector arrangements were constructed, one in the Panamint Valley for cross-track target resolution, and one in the Pahrump Valley for along-track target resolution. Rosamond dry lake was used for small target clusters and Moving Target Indication (MTI) evaluation. Fifty-three flights were flown during the test programme, which ended on 21 June 1968 after having met all goals.[16]

## TF-104G (Model 583-10-20)

Designation applied to the two-seat advanced combat trainer version of the F-104G. The TF-104Gs were combat-ready aircraft fitted with NASARR and underwing racks for carrying stores. Including 48 TF-104G (583C/D/E/F/G & H) aircraft with components manufactured by the European consortiums, Lockheed built a total of 220 TF-104Gs in these six versions.

The Models 583C to 583H were respectively for MAP delivery to the *Luftwaffe* and the *AMI* (Italian Air Force) and for direct delivery to the *KLu* (Royal Netherlands Air Force), the *Luftwaffe* and the *Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu)* and the *AMI*. Germany received 136 TF-104Gs from Lockheed, thirty of which were retained in the US where they were used at Luke AFB, Arizona, for training *Luftwaffe* pilots. The TF-104G had a similar basic airframe to the single-seat version and carried the full NASARR radar. The type was intended principally for pilot training in low-level navigation. Both the autopilot and the Vulcan cannon were deleted, as was the centreline rack for the nuclear store. Fuel tanks and avionics were relocated to make



**Canadair-built (MAP) F-104G 64-17778.** Canadair room for the additional cockpit. The TF-104G could carry missiles and additional fuel tanks, fuel capacity being reduced by 180 Imperial gallons.

## RTF-104G1

Designation given to a projected all-weather, day and night photographic reconnaissance version of the TF-104G1 fitted with cameras, infrared and sideways-looking (SLAR) radar for use by the *Luftwaffe*. The RTF-104G1 never emerged from the proposal stage as the *Luftwaffe* instead chose the McDonnell RF-4E Phantom II for the reconnaissance mission.

## F-104G ZELL

**Fiat-built F-104G for the AMI. The Italian Group, led by Fiat and including Aerfer-Macchi, Piaggio, SACA and SIAI-Marchetti, built 169 Starfighters, flying its first F-104G on 9 June 1962. The AMI received 125 of these (F/RF-104Gs) as well as 24 Lockheed-built TF-104Gs.** Fiat

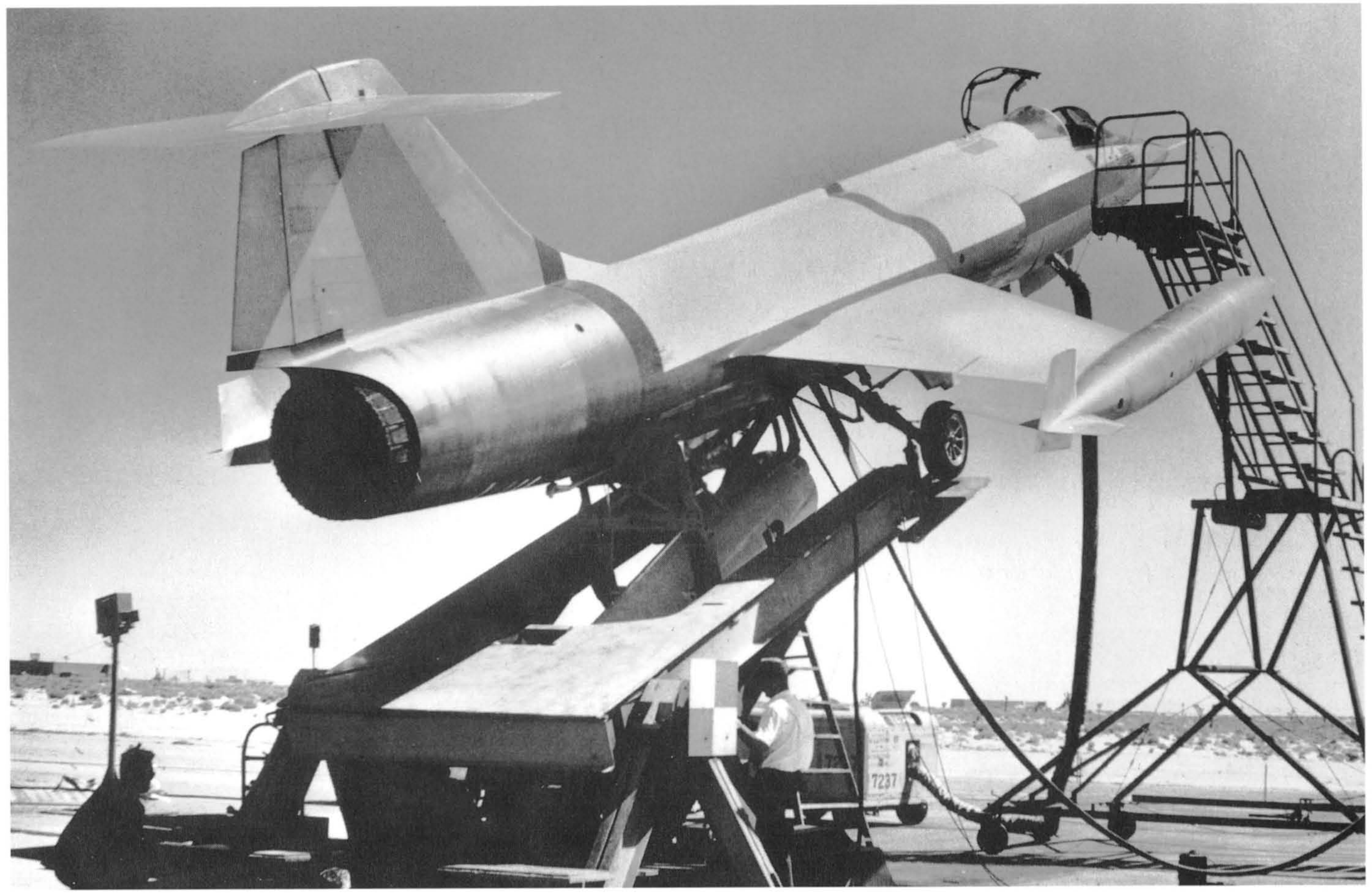
The Zero-Length-Launch, or ZELL programme was conducted in great secrecy at Edwards AFB on the second production F-104G, which at the time carried the German identification DA+102 (Company 2002). The *Luftwaffe* had identified a need to launch their F-104s from no-runway areas in Europe and so the rocket-boosted concept was conceived. DA+102 was structurally modified to accept an RS B-202 rocket booster manufactured by Rocketdyne. The booster was 29in (74cm) in diameter, 13ft 3in (4m) long, weighed 4,175lb (1,894kg) and developed 65,000lb (29,484kg) of thrust for 7.9 seconds.

The F-104 was mounted in a 20 degree nose-up attitude on a static launcher. Prior to ignition of the booster, the J79 was started and advanced to full afterburning thrust. Hold-back fittings kept the Starfighter in position on the launcher until the booster was ignited, causing them to shear and release the F-104.

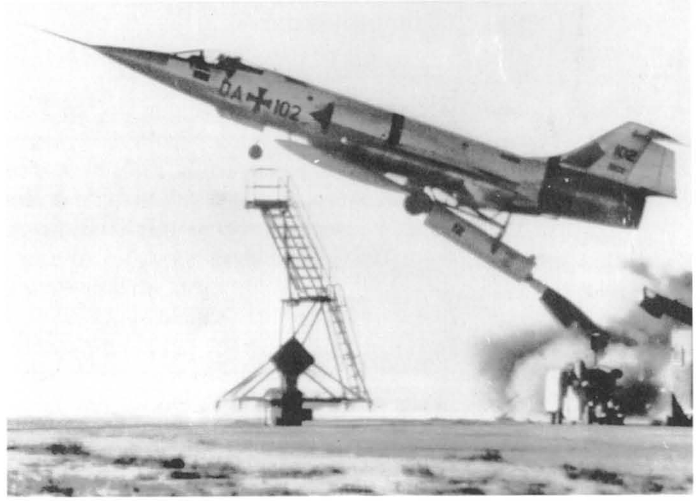
F-104G ZELL configurations resulting in gross weights of 23,900lb to 28,600lb (10,841kg to 12,973kg) were launched by this combined thrust (engine and booster) of 80,800lb (36,651kg). At booster burnout, the ZELL was about 2,000ft (609m) downrange at anything from 420 to 700ft (128m to 213m) AGL, and 250 to 350 KIAS depending on the weight. The Starfighter's landing gear retracted automatically following separation from the launcher. The booster and its cradle were then jettisoned and the F-104G ZELL proceeded with the scheduled test mission. In the heaviest launch configuration, the ZELL contained full wingtip fuel tanks, full pylon fuel tanks, and a 200lb (90.7m) centreline mounted bomb.

Prior to launches of the actual aircraft, Lockheed constructed for launch several 'Iron Crosses' – concrete and steel beam replicas of the F-104 airframe with weight, centre of gravity and moment of inertia accurately duplicated for various external store configurations. The launch of the second such 'iron cross' resulted in separation of the booster rocket, which collided with the dummy aircraft and began burning out of both ends, which one Lockheed observer described as 'resembling a huge 4th of July pinwheel fireworks display'. Several flight test crew members were

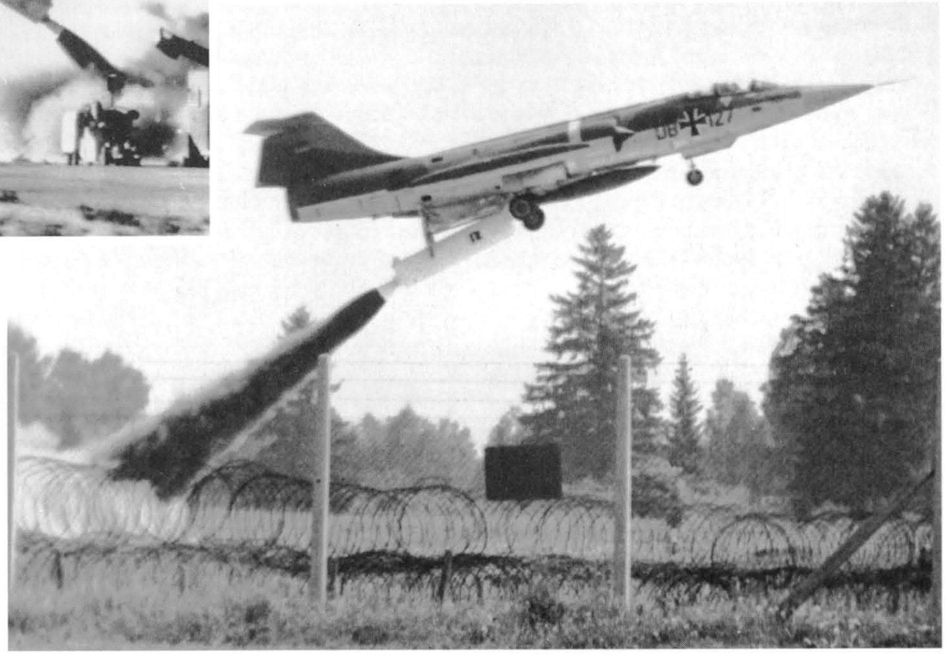
**NF-104A (F-104A) 56-762, one of three delivered to NASA, on 1 November 1963. This Starfighter was finally retired in June 1971.** Lockheed



**F-104G ZELL on the launching ramp in California. The Zero-Length-Launch, or ZELL programme was conducted in great secrecy at Edwards AFB. The** Luftwaffe **had identified a need to launch their F-104s from no-runway areas in Europe and so the rocket-boosted concept was conceived. Altogether, twelve dummy and eight piloted launches were carried out in two phases. The first involved a Lockheed-built launcher while the second involved evaluation of a different launch platform manufactured by Vereinigte Flugtechnische Werke (VFW) in Germany. The first phase took place during 14 December 1962 to 28 August 1963 and the second phase took place during 18 March 1964 to 22 July 1964.** Lockheed



***(Above)* F-104G ZELL DA+102 (WerkNr.2002), the second production F-104G, being launched in March 1966. DA+102 was built in 1960 and was structurally modified to accept an RS B-202 rocket booster manufactured by Rocketdyne. The booster weighed 4,175lb (1,894kg) and developed 65,000lb (29,484kg) of thrust for 7.9 seconds.** via *Aeroplane*



**The same F-104G, now coded DB+127, being rocket launched at Lagerlechfeld, Germany, with Lockheed test pilot Edward Brown in the cockpit, on its second flight in Germany, for the press, on 18 May 1966. (It had first flown in Germany on 4 May 1966). This aircraft is now on display at the Luftwaffe Museum in Berlin (Gatow).** via Philip Jarrett

**After flight testing some improvements on a modified RF-104G (61-2624), Lockheed received an Italian contract to modify two F-104S models for the AMI, using Fiat-built F-104G airframes (MM6658 and MM6660) as prototypes for an advanced all-purpose Starfighter with improved capability both as an interceptor and as a fighter-bomber for the** caccia ogni tempo **(multi-role, all-weather interceptor) version for the AMI (Italian Air Force).** Lockheed

injured, not by the rocket, but by fleeing the scene and stepping in chuck holes or running into vehicles. The problem with the separation of the booster rocket was soon remedied and Lockheed went on to launch seven 'iron crosses' before the F-104G ZELL tests began. Subsequent to the first piloted launch, dummy and piloted launches were intermixed to clear new stores configurations.

Altogether, twelve dummy and eight piloted launches were carried out in two phases. The first involved a Lockheed-built launcher while the second involved evaluation of a different launch platform manufactured by *Vereinigte Flugtechnische Werke (VFW)* in Germany. The first phase took place during 14 December 1962 to 28 August 1963 and the second phase took place during 18 March 1964 to 22 July 1964. A few problems occurred prior to the initial aircraft launches. The access stand to the cockpit was rather high and made it difficult to reach switches from the platform. On a mission preflight, the crew chief reached into the cockpit to pull the drag chute handle, got the wrong one and jettisoned the canopy.

On the day of the first real launch, test pilot Ed Brown, was obviously nervous – he overslept and was late for the scheduled launch time. Following the successful first live launch, Brown, an ex-Navy carrier pilot, described the sensation as 'much gentler than a cat shot'. Flight test data verified that indeed only two Gs longitudinal acceleration were experienced. Eight piloted launches were accomplished with amazingly few problems, and a follow-on programme involving several additional launches was conducted in Germany.

Most of the challenge of the ZELL programme involved ground support equipment which had to be designed or modified to handle the booster/cradle installation, loading and unloading of the aircraft on the launcher, and boresighting the booster. Several iterations of engine/booster exhaust gas deflector channels were tried before a successful configuration was developed. The hold-back fixtures were redesigned to eliminate interference with the landing gear. The final report contained the statement 'Zero-length launches of the F-104 aircraft have been demonstrated to be entirely feasible'.[17]

## F-104H

Designation given in 1964 to a projected Lockheed simplified single-seat version of the TF-104G (with an optical gunsight in place of NASARR) for export, but which was unbuilt. This model would have been a simplified F-104G with the Autonetics F15A NASARR fire control system eliminated and an optical gunsight, and it was designed to be able to carry out both the interceptor and strike roles. Empty weight was 13,492lb (6,120kg) and maximum overload weight was 28,440lb (12,900kg). This version was offered to Saudi Arabia, which preferred to buy the English Electric Lightning instead.

## TF-104H

Designation given to a projected, but unbuilt, simplified two-seat version of the TF-104G with the same specifications as the F-104H, for export.

## F-104J (Model 683-07-14)

Designation applied to 210 aircraft structurally similar to the F-104G but equipped as an all-weather interceptor and powered by a J79-1H1-11A turbojet built under licence by Ishikawajima-Harima. The first three F-104Js were produced and flight tested by Lockheed, after which they were dismantled and shipped to Japan. A further twenty-nine were assembled by Mitsubishi Jukogyo KK (Mitsubishi Heavy Industries Ltd) at their Komaki plant in Japan, and by Kawasaki, from Lockheed components, and 178 were built in two batches in Japan. The first Lockheed-built F-104J flew on 30 June 1961 and the first flight of a F-104J in Japan was made on 8 March 1962. Deliveries to the *Nihon Koku Jieitai* (Japanese Air Self-Defence Force/JASDF), took place during March 1962 to March 1965. The first aircraft, a J, was delivered to the JASDF in April 1962. By the end of 1962 some thirty-two (twenty-four F-104Js/eight DJs) had been delivered; in 1963 seventy (sixty F-104Js/ten DJs); in 1964, ninety-eight (ninety-six F-104Js/two DJs), 1966 seven F-104Js; and a final batch of twenty-three F-104Js delivered in 1967.

## F-104K to F-104M

Designations not assigned.

## F-104N

Three Starfighters built as F-104Gs by Lockheed (683C-4045, 683C-4053, and 683C-4058) were delivered to NASA between August and October 1963 as F-104N supersonic chase planes (*see* Chapter 9).

## F-104P to F-104R

Designations not assigned.

## F-104S Model (CL-901)

Designation given to the multi-role, all-weather interceptor (*caccia ogni tempo*) version of the F-104G produced in Italy for the AMI for interception and interdiction/strike duties, and for Turkey for interception. After flight testing some improvements on a modified RF-104G (61-2624), Lockheed received an Italian contract to modify two Fiat-built F-104Gs (MM6658 and MM6660, which were delivered to Lockheed in 1966) as prototypes for an advanced all-purpose Starfighter with improved capability both as an interceptor and as a fighter-bomber.

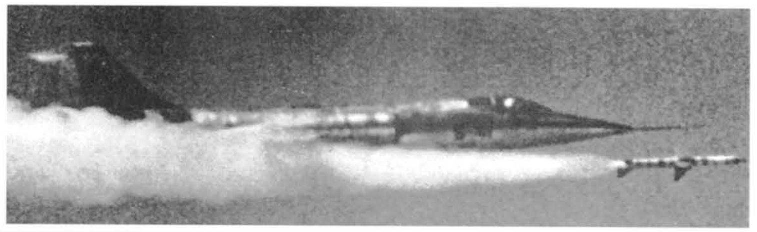
**F-104DJ trainers and F-104J single-seat models await delivery to the** Nihon Koku Jieitai **(Japanese Self Defence Force) in the pre-flight hangar at the Mitsubishi Heavy Industries' Komaki plant near Nagoya. Nearest aircraft is F-104G but was equipped as an all-weather interceptor and powered by a Japanese-built J79 turbojet. Three were built by Lockheed and Mitsubishi Jukogyo KK (Mitsubishi Heavy Industries Ltd) assembled a further 29 from Lockheed components before building 178 more. The first Lockheed-built F-104J was flown on 30 June 1961.** Lockheed

This entailed the removal of the M-61 20mm cannon and its ammunition can, replacement of these units with the Raytheon Sparrow missile control/CW radar system, addition of two new wing stores stations, pylons at BL104 for two underwing Raytheon AIM-7 Sparrow III radar-seeking missiles and/or two AIM9 Sidewinder missiles, incorporation of the fuselage-mounted stores stations at BL22, upgrade of the F-15A NASARR radar to the R-21G configuration and integration of the Raytheon system with it. (Part of the radar development programme involved experimentation with different radomes, including a U-2 radome, which greatly changed the appearance of the F-104G).

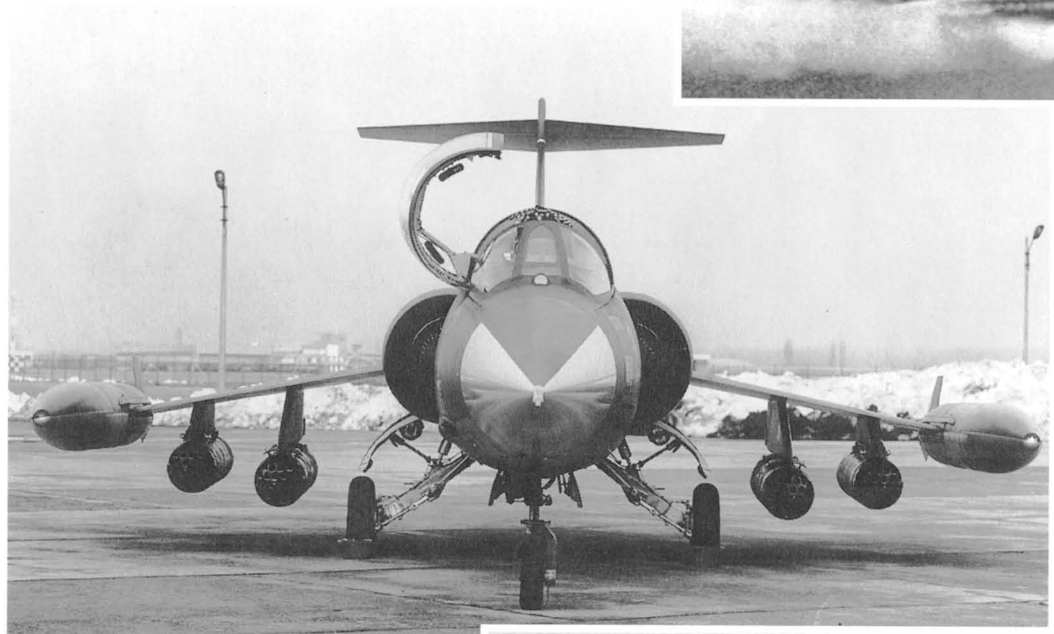
The additional hard-points gave the F-104 a total of nine, one at the fuselage centreline, two at fuselage BL22, four wing pylon stations at BL75 and BL104, and two at the wingtips. The new Starfighter became a multi-mission interceptor/fighter-bomber capable of carrying widely varied weapons mixes. It could, for instance, be configured with four AIM-9 Sidewinders and two AIM-7 Sparrow IIIs for the Interceptor role, or up to ten M-117 750lb bombs or napalm tanks or rocket pods for the bombing mission. In this configuration, the 'lightweight' fighter exceeded 31,000lb gross weight. This increase in weight, and a need to improve overall performance, led the fitting of the J79-GE-19 of 11,870lb (5,384kg) static thrust and 17,900lb (8,119kg) with afterburner.

The basic F-104G contained a fixed-frequency, hydraulic-driven AC generator. In order to provide power for the Sparrow system, a second such generator was added to the F-104S model. Auxiliary inlet doors were provided for the added air requirement

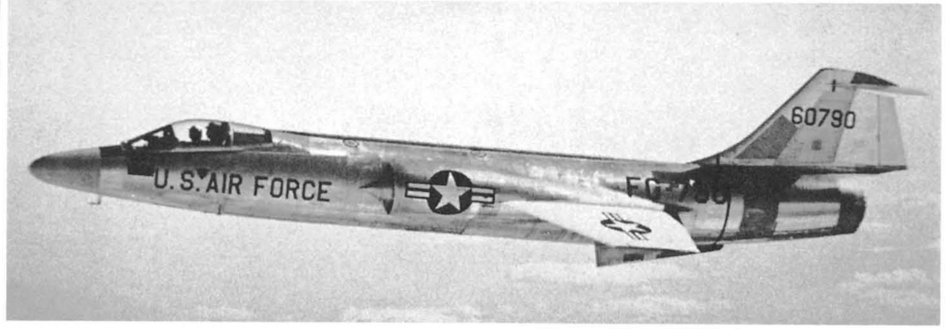
**(*Below*) Aeritalia built F-104S for the AMI. The first Italian-built 'S' flew on 30 December 1968. Total production by Fiat-Aeritalia ceased in March 1979 after 245 F-104S models, including 40 F-104S models for the** Türk Hava Kuvvetleri (THK, **Turkish Air Force), had been produced.** *Aeroplane*



**(*Above*) The second F-104S prototype (MM6660) test firing a Sparrow missile. MM6660 was fitted with the complete Sparrow system and was the primary avionics/fire control system test vehicle. The test programme was conducted during 1967 and 1968.** Lockheed



**(*Below*) F-104A-20-LO 56-790 was acquired by NASA in December 1966 to replace the loss of 56-749 and during the radar development programme for the F-104S was involved in experimentation with different radomes, including a radome from a U-2.** Lockheed



by the J79-GE-19 engine. Two additional ventral fins were provided for stability. The F-104S model's Mach limit was increased from 2.0 to 2.2.

The first Lockheed-modified F-104S (MM6658) was flown on 30 December 1966. The flight test programme afforded a number of avionics system challenges. The Sparrow missile control system had never been integrated with the NASARR fire control radar, and the missile had never been as much as separation-launched from the F-104. Two F-86H Sabres were used during the flight test programme in roles as chase and target. As targets, they were RCS-enhanced by Luneberg lenses mounted in their tails. The first F-104S did not contain the Sparrow missile control system and was used or aerodynamic tests, systems tests and weapons separation tests. The second (MM6660), was fitted with the complete Sparrow system and was the primary avionics/fire control system test vehicle. The test programme was conducted during 1967 and 1968 and 71 flights were flown on the avionics aircraft alone. An additional 63 flights were flown on this aircraft in a follow-on programme to evaluate production avionics fire-control systems.

Early in the programme, MM6658 was to launch a Sparrow at limit Mach 2.2 for separation purposes. Several earlier launches at lower Mach numbers had been successful. The only aircraft which could keep up with the S was the Navy's new F-4J. Since all missile firings in the programme were conducted at the Pacific Missile Test Range at Point Magu, it was no trouble to schedule an F-4J from VX-4. The acceleration characteristics of the two airplanes were considerably different from each other in the various subsonic regimes, resulting in an interesting 'drag race' but not-so-good chase photos. Just as the test airplane achieved Mach 2.2, the second hydro-generator tripped off the line, removing power from the test missile and causing an abort. This was subsequently discovered to be a generator overheat caused by airflow stagnation in the (new, of course) shared cooling duct for the two hydro-generators. A slight redesign cured the problem.[18]

Initial missile-fire control integration testing included a 'three-plane captive' flight involving the avionics F-14S acting as interceptor, illuminating the target and missile with the fire control radar. An F-86H acted as a target, and the systems F-14S as the missile carrier. The missile carrier airplane started in formation with the illuminator, and after lockon, accelerated toward the target. By using the F-104 to carry the instrumented missile, it could act as the missile in flight by closing on the target, as data transmitted from the missile telemetry was monitored. All test missiles carried telemetry packages in lieu of warheads, and ground telemetry stations were located at Lockheed Palmdale and at Raytheon's plant near Point Magu.

After missile and fire control integration testing was completed, an ambitious series of planned line firings against drones was undertaken at Point Magu. They progressed from relatively benign tail-on aspect launches to the one we called 'FF-5', with the F-104 in a quartering head-on aspect at Mach 1.7 to an AQM-37 drone at supersonic speed. The first live shot scored a direct hit on the subsonic BQM-34

drone, exploding the drone's full tank and prompting test pilot Ken Weir to push for installation of a gun camera for the next launch, which we did. Remember, the missiles did not contain warheads, and the idea was to recover the drones for re-use, not destroy them. We did, however, destroy or damage five with direct hits. The code word for a near miss was 'Boola' in the Point Magu control room, and a direct hit was 'Boola-Boola'. We heard those terms on every shot. Ken Weir accounted for four of the drones, making him a near-ace. The FF-5 mission was particularly difficult, with a six second window between target acquisition and missile launch.

On supersonic firings over Point Magu, the airplane frequently recovered at Point Magu due to low fuel. Both airplanes were unmarked except for a number, were painted in European camouflage, and would land with a single Sparrow and a bare pylon opposite following a firing flight.

One of the unplanned challenges which took place early in the development involved the Sparrow Line-of-Sight (LOS) signals we were recording as part of the test effort. They never seemed to work, at least did not show up on the oscillograph (yes, oscillograph) records. These signals were of very low (millivolt) magnitude, and were crucial to the Sparrow antenna pointing accuracy. A very involved investigation took place, and the bottom line was found to be conductive potting compound used in the missile pylon adapters. High level signals were not affected, but the LOS certainly were. This problem had to be solved prior to any live missile firings involving subsequent guidance.

Overall, this was a highly successful fire control improvement and integration programme, and some S models are still in service with the Italian Air Force.

The first Italian-built 'S' flew on 30 December 1968. Total production by Fiat-Aeritalia ceased in March 1979 after 245 F-104S models, including 40 F-104S models for Turkey, had been produced.[19]

## F-104S ASA

In 1983, Italy decided to upgrade 153 of its F-104S models to ASA (*Aggiornamento Sistema d'Arma*, or updated weapons system standard to enable the Starfighter to detect, track and shoot down low-level intruders. The original FIAR R21G/H radar was replaced by Fiat R21G/M1 Setter with look-down/shootdown capability and fire control system. Selenia Aspide 1A medium- to long-range, radar-guided air-to-air missiles based on the Raytheon AIM-7E Sparrow AAM, replaced the Sparrows, and fuselage rails were added for AIM-9L Sidewinder missiles. Improved IFF, more modern internal electronic countermeasures (ECM) systems, and the addition of an automatic pitch control computer, were also fitted. Provision was also made for a reconnaissance camera pod.

Flight trials of a modernized F-104S ASA demonstrator began in December 1984, and subsequently, 206 F-104S models were upgraded to F-104S ASA standard. By the beginning of 1995 the ASA still had 125 F-104 ASA models in its inventory among seven *gruppi*.

For air intercept sorties the F-104S typically carries an AIM-9L dogfight missile under the port wing, an Alenia Apside 1A missile under the starboard wing, and two wingtip tanks. In the fully loaded, but rarely used, interception configuration, the F-104S ASA carries four Sidewinders (two on fuselage rails, two on the wing tips), two Aspides, and two drop tanks. All remaining F-104S ASA models are scheduled for replacement by the Eurofighter 2000.

**CF-104 12701, the first of 200 CF-104 Starfighters for the Royal Canadian Air Force (RCAF), which first flew in July 1961. As the Canadair-built CF-104s were not armed with the M61 Vulcan cannon both the gun ports and the gun gas vents were faired over. The M61 cannon was retrofitted on CF-104s in 1971, when Canada changed its Germany-based Starfighters from nuclear strike to conventional ground attack. The Royal Canadian Air Force (Canadian Armed Forces from 28 February 1968) ultimately received 200 CF-104s and 38 two-seat CF-104Ds.** *Aeroplane*

## CF-104 (CF-111)

Designation applied to 340 (CL-90) Starfighters built under licence by Canadair, with the Orenda-built J79-OEL-7 engine of 10,000lb static thrust (4,550kg) and 15,800lb (7,180kg) with afterburner. The first 200 aircraft (initially designated CF-111 by the Royal Canadian Air Force) were built under a licence agreement from Lockheed on 24 July 1959. Externally, these aircraft were little different from the F-104G. They retained provision for the removable refuelling probe as fitted to US Air Force Starfighters, but the R24A NASARR was optimized for the air-to-air role, and the Vulcan cannon was removed and replaced by additional fuel tanks.

Other equipment was as specified by the RCAF. This included a Vicon ventral reconnaissance pod with four Vinten 70mm cameras and electronic sensors manufactured by Computing Devices of Canada. CF-104s also had larger tyres on the main undercarriage and Dowty-patented liquid springs with longer stroke. The first Canadair CF-104 was airlifted to Palmdale, California, where it first flew on 26 May 1961. The first CF-104 to fly in Canada was number four, which flew in August that year. The last of 200 CF-104s for the RCAF was completed in September 1963.

These were followed by 140 Canadair-built F-104Gs as part of the Military Assistance Programme (MAP). In *Kongelide Danske Flyvevåbnet* (*KDF*, Royal Danish Air Force) and *Kongelige Norske Luftforsvaret* (*KNL*, Royal Norwegian Air Force) service, ex-RCAF/CAF CF-104s (and CF-104Ds) were modified to F-104G and TF-104G standard respectively.

## CF-104 (CF-113) (Model 583-04-15)

Designation applied to 22 CF-113 (later CF-104D) two-seat advanced trainers, and 16 two-seat advanced trainers (which, fitted with slightly different equipment, were designated CF-104D Mk.II) built by Lockheed for the Royal Canadian Air Force (RCAF) (later Canadian Armed Services/CAF). All were powered by the Orenda-built J79-OEL-7 engine.

## CL-1200 Lancer

Designation of a Lockheed Skunk Works second generation project derived from the F-104, with the same fuselage, but with new, shoulder-mounted wings of increased area, and its tailplane moved from the tip of the vertical and relocated to the base of the aft fuselage. A more powerful Pratt & Whitney TF30-PW-100 or F100-PW-100 turbofan engine was chosen to power the new Starfighter. Gross weight was estimated at 35,000lb (15,900kg) or 17.5 tons, and top speed at 1,700mph at 35,000ft (2,735km/h at 10,670m). Although the proposal, made in 1961, as a concept for the lightweight fighter of the 1980s and 1990s, at one time looked as if it would be a success (the USAF did consider acquiring one or more Lancers as X-27 research aircraft in support of the programme), the aircraft finally lost out to the Northrop F-5E Tiger II in November 1970 and the Lancer never entered production.

## CL-704 VTOL strike and reconnaissance aircraft

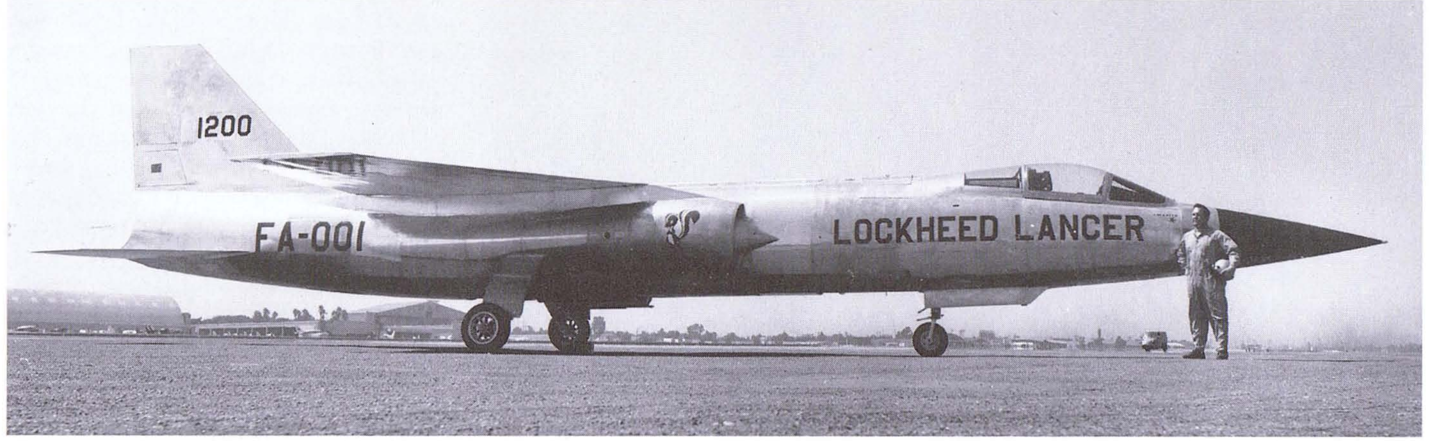
The F-104/VTOL (Vertical take-off and landing) project was first proposed in 1962. It would have seen the F-104G fitted with wingtip lift engine pods and Rolls-Royce RB.181 lift engines and a fuselage-mounted RB.168R main propulsion engine. Lockheed and Short Brothers and Harland of Belfast (who had pioneered VTOL with its 'flying bedstead' project) discussed the proposal in which the wingtip pods were to contain seven vertically mounted lift engines with detachable fuel tanks fore and aft of the stainless-steel powerplant bay.

Each lift engine was to have forward-facing inlet door that would adjust automatically for different air flow conditions. Swivel nozzles were to direct air flow downwards from the pods through a 15 degree arc on either side of the vertical thrust line. By deflecting the nozzles simultaneously, the pilot would be able to control fore and aft movements while hovering. They would also be used, by differential deflection, for yaw control. Pitch control would be achieved by varying pitch settings between the four forward and three rear lift engines, and through a pitch-control vane installed in the main engine exhaust system.[20]

The F-104G/VTOL programme never reached production because apart from the exceptionally high cost of fuel needed to blast the Starfighter off the ground, the advanced nature of the true-VTOL aircraft, the British made Hawker P1127 Kestrel, made the F-10G/VTOL virtually redundant at birth. (The P1127 design, which was evaluated by the Tripartite squadron consisting of US, RAF and *Luftwaffe* pilots, ultimately led to the highly successful Harrier VTOL jet.) (A larger-wing F-104 development was also proposed as an alternative to the MRCA (Multi Role Combat Aircraft) then being designed as a multinational European project.)

## X-27 (CL-1600)

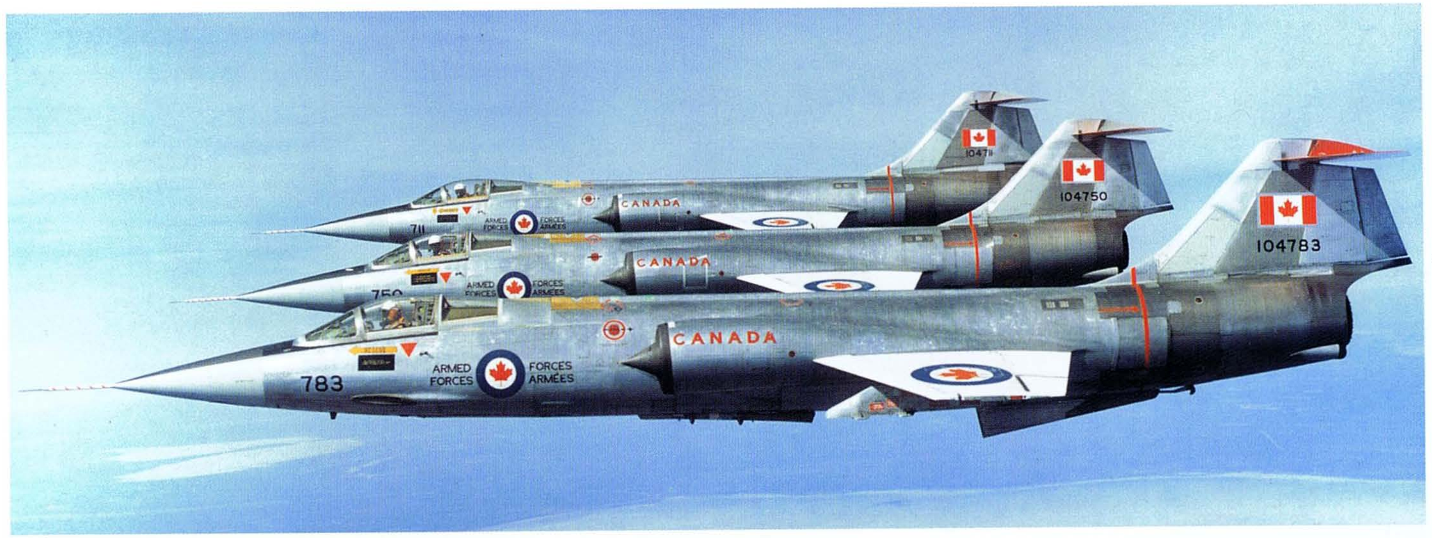
In 1970 the US Air Force wanted to acquire a number of CL-1200 Lancers for use as high-performance-engine test aircraft. The USAF planned to procure one experimental Lancer, to be designated X-27. Similar to the CL-1200, the X-27 however featured modified engine air inlets of rectangular shape. The X-27 programme was terminated through lack of funding before any aircraft could be built.



**In 1961 the Lockheed Skunk Works created a second generation Lancer 1200 project derived from the F-104, with the same fuselage, but with new, shoulder-mounted wings of increased area, and its tailplane moved from the tip of the vertical and relocated to the base of the aft fuselage. It also had a more powerful Pratt & Whitney turbofan engine giving a top speed of 1,700mph at 35,000ft (2735km/h at 10,670m). In November 1970 the Lancer lost out to the Northrop F-5E Tiger II in the lightweight fighter contest and none entered production.** Lockheed

**(*Above*) F-104A-1-LO 56-736 in flight.** Lockheed

**(*Left*) XF-104-LO prototypes 53-7786 and 53-7787 in formation.** Lockheed



**(*Below*) CF-104s 104783, 104750 and 104711 in formation.** Andy Graham via Stephen Fochuk

**(*Bottom*) CF-104 104789 being refuelled at a Royal Canadian Air Force base.** Andy Graham via Stephen Fochuk

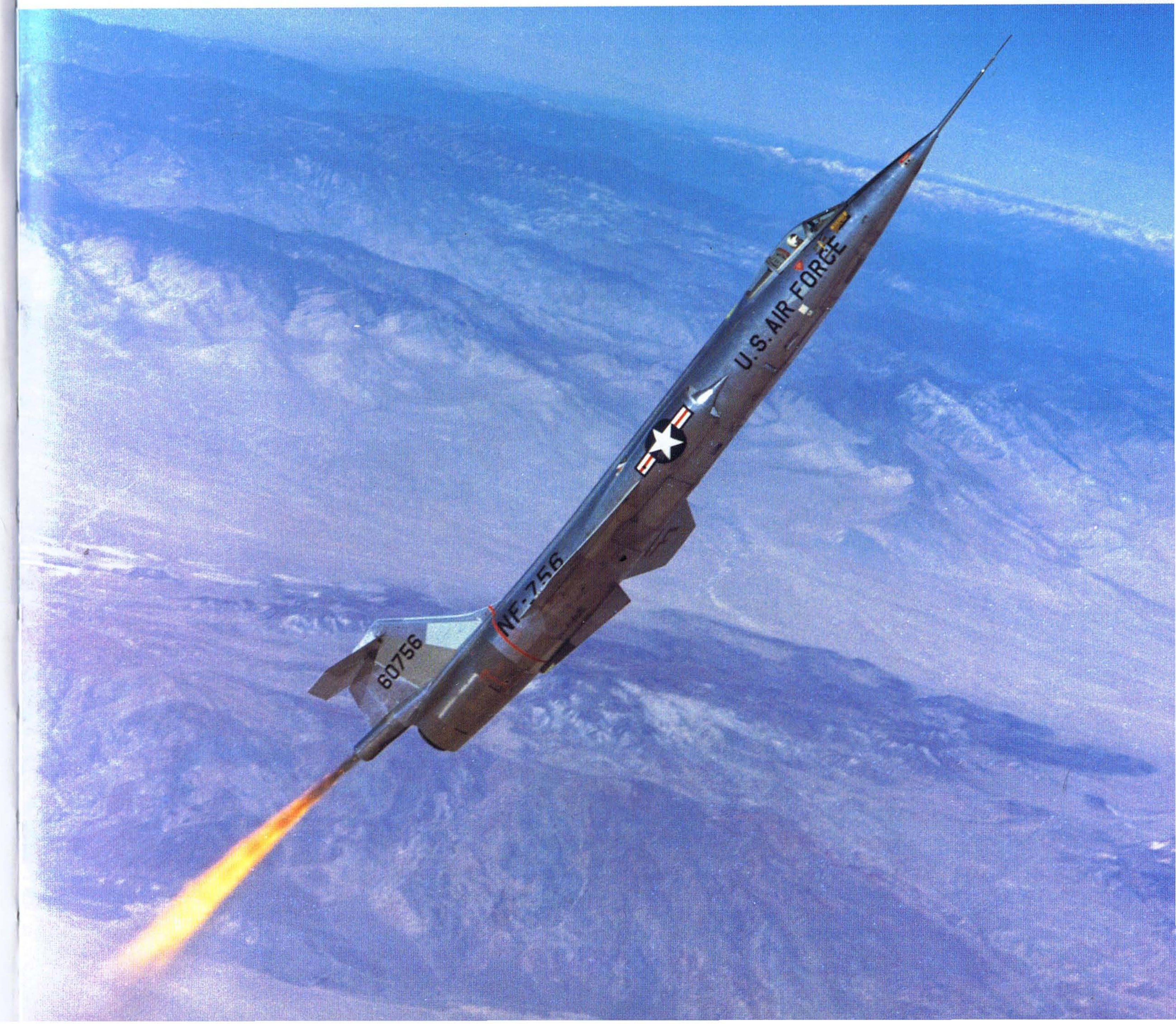
**(Above) CF-104 104895 firing rockets over the Cold Lake flying area of Canada.** Andy Graham via Stephen Fochuk

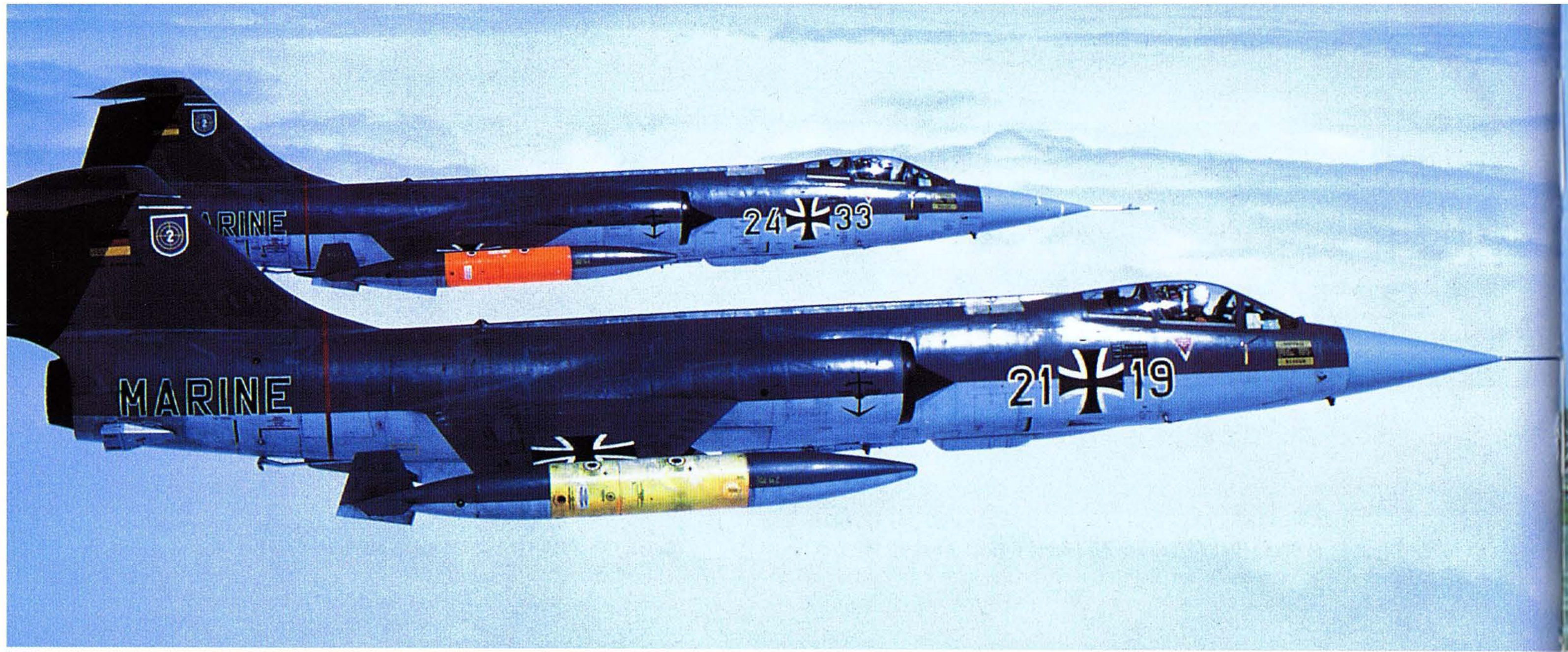
**(Below) Single-seat F-104Js and dual-seat F-104JDs of the** Nihon Koku Jieitai **(Japanese Air Self Defence Force/JASDF).** Lockheed Martin Skunk Works

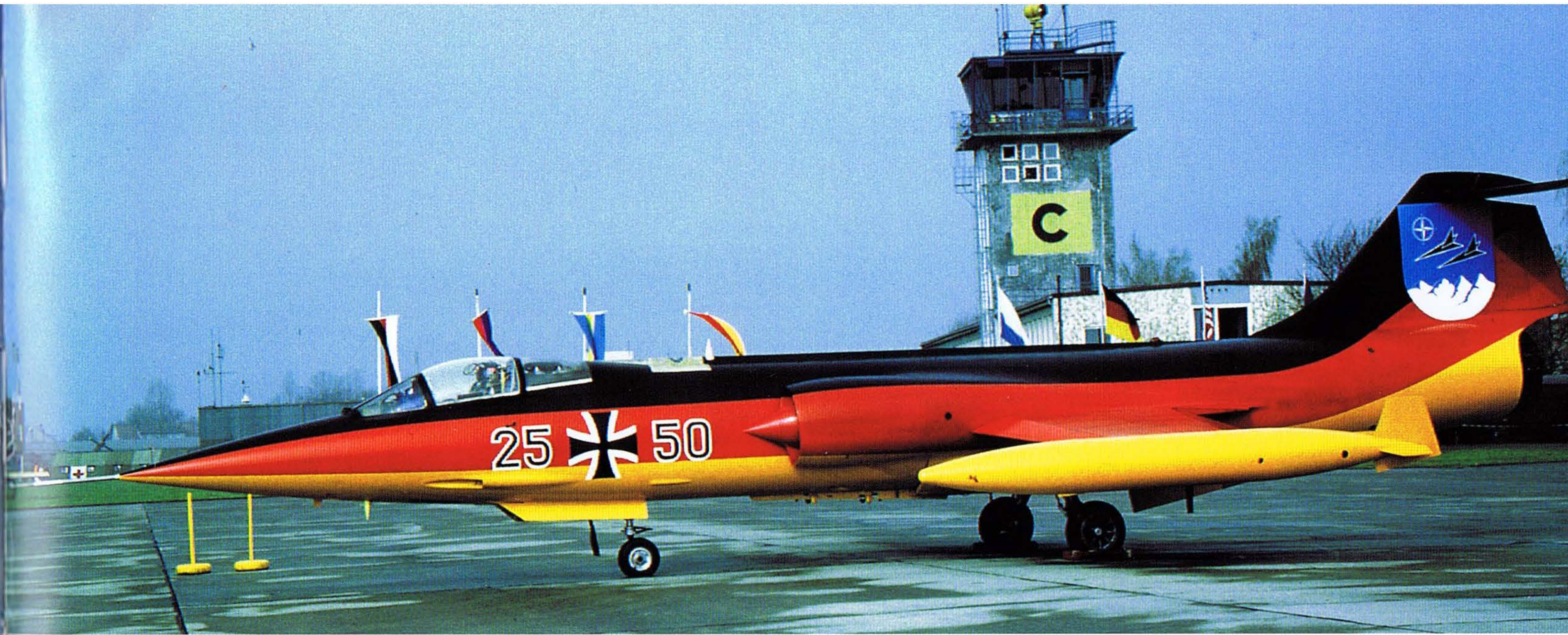
**(Below) Ex-**Luftwaffe **F-104G-LO (63-13294) 4371 which operated with the Taiwan Air Force from 1983 to 8 August 1996.** Ton van der Zeeuw

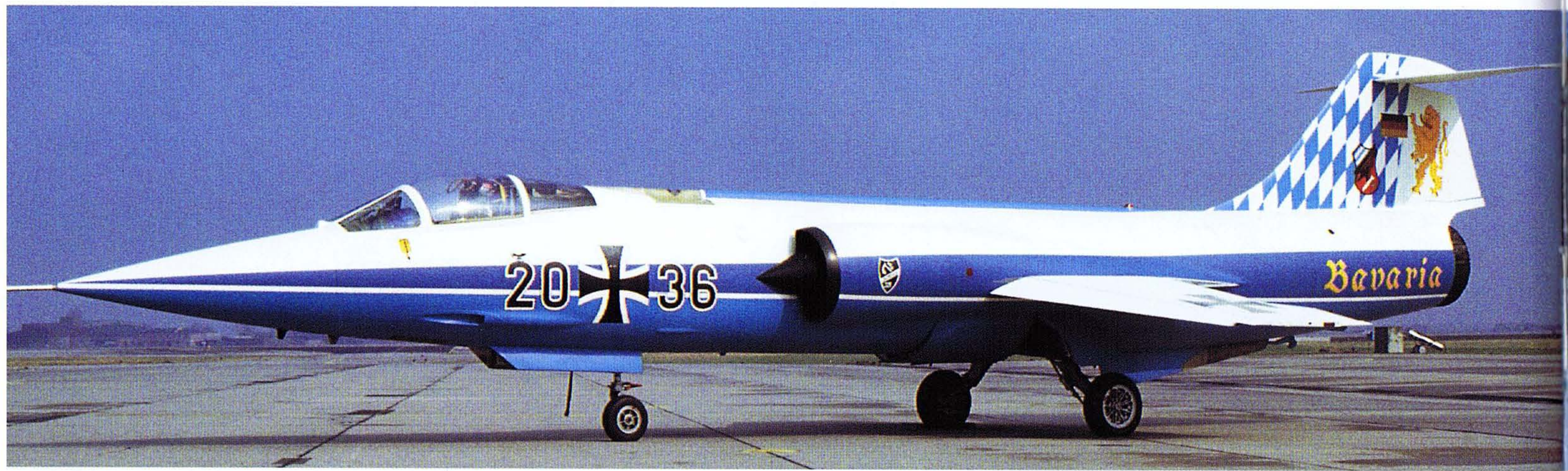
**Ex-Republic of China (RoCAF/Taiwan Air Force) F-104B (57-1298) 902/C of the** Al Quwwat Aljawwiya Almalakiya Alurduniya **(Royal Jordanian Air Force), which the two-seater joined late in 1966; it is now displayed at Mafraq.** Ton van der Zeeuw

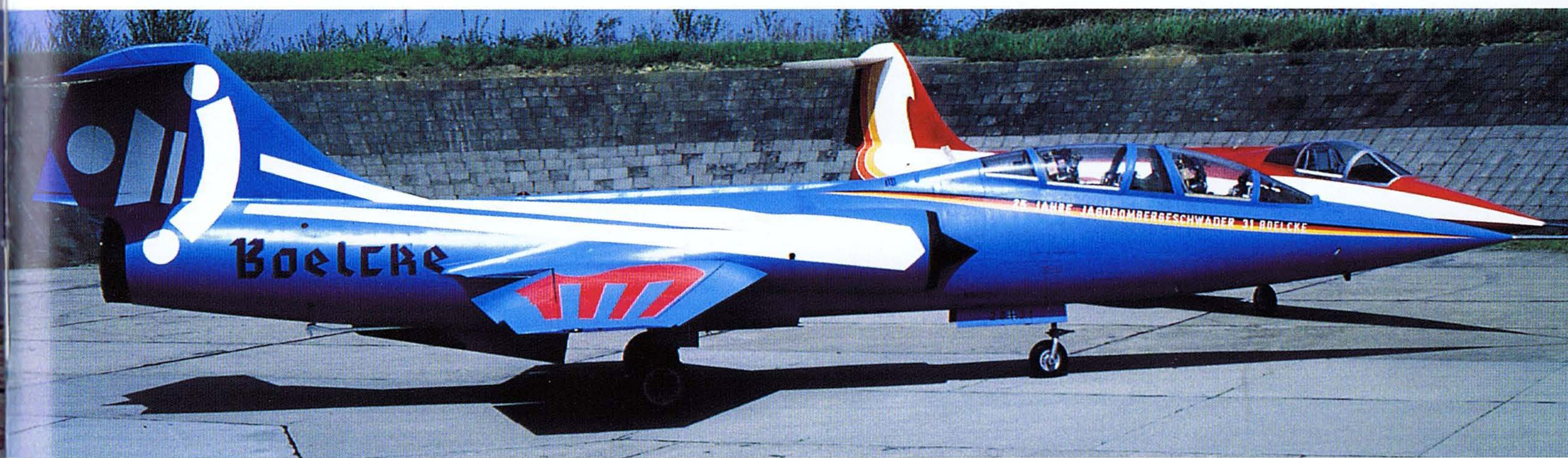
**(Below) NF-104A-LO 56-0756 zoom-climbing over the Mojave desert, its Rocketdyne rocket motor at full 6,000lb (2,722kg) thrust. 56-0760 is now on display at the USAF Test Pilots School.** NASA/AFMC History Office

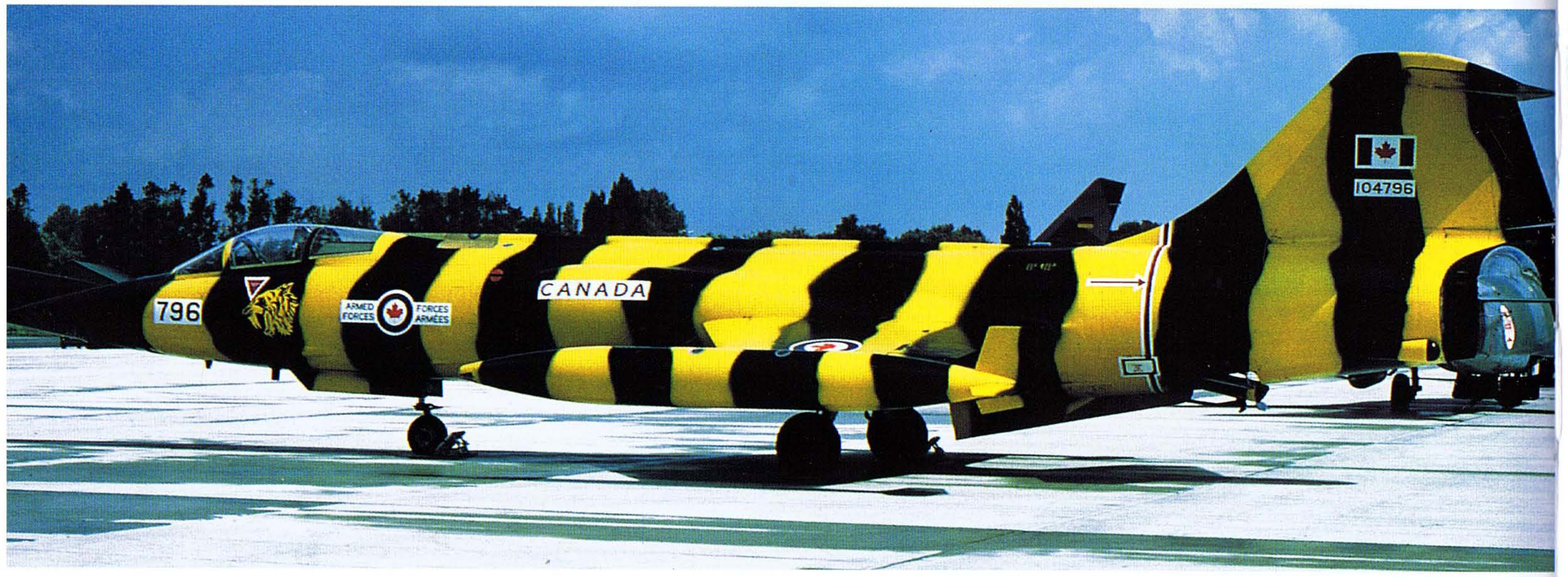


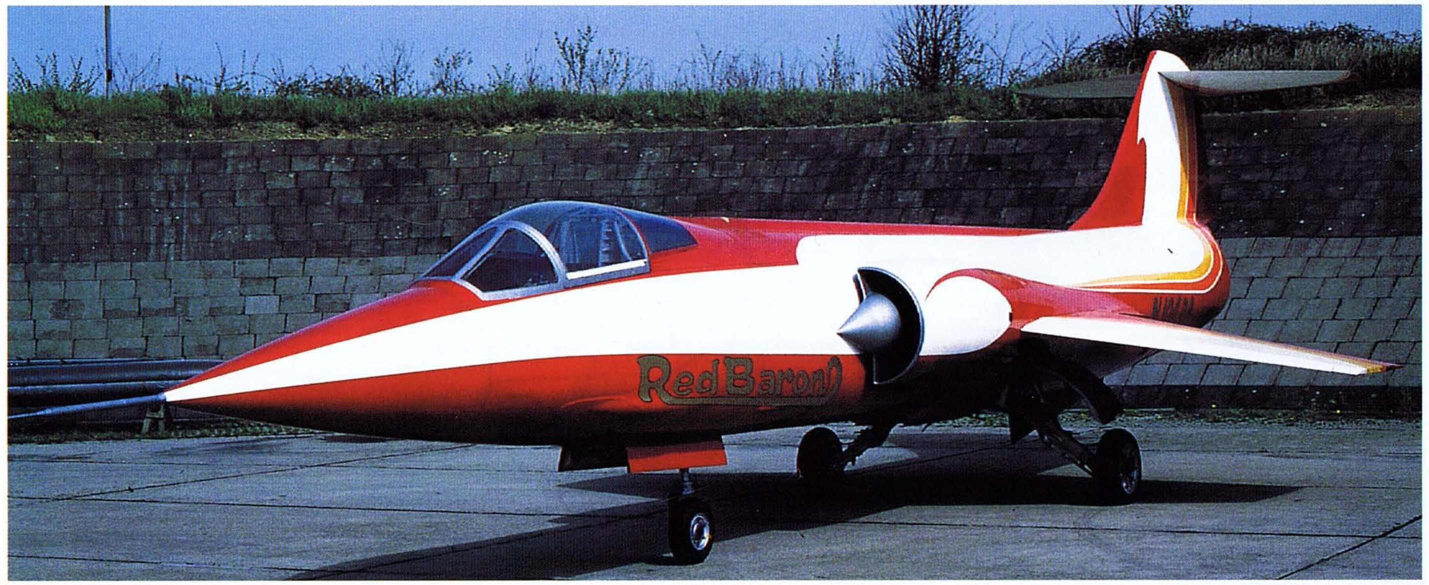












*(Top)* F-104G 21+19 and RF-104G 24+33 of MFG2 of the Marineflieger. 21+19 first flew on 23 April 1965. It made an emergency landing in Greenland while en route to the USA, on 20 August 1986. It was shipped back to Eggebek on board a Transall C-160 and repaired. It was later acquired by the Greek Air Force on 16 December 1986 and served with the 116 Ptérix Mahis (Combat Wing) at Araxos. 24+33 first flew on 13 November 1963 and was issued to WaSLw.10, then JaboG36, and finally, MFG2. It suffered a blown tyre on landing at the French naval base at Lann-Bihoué on 1 October 1980. On 19 February 1986 it was acquired by the Greek Air Force and serialled 'FG-176' with the 114 Ptérix at Araxos. CONAM

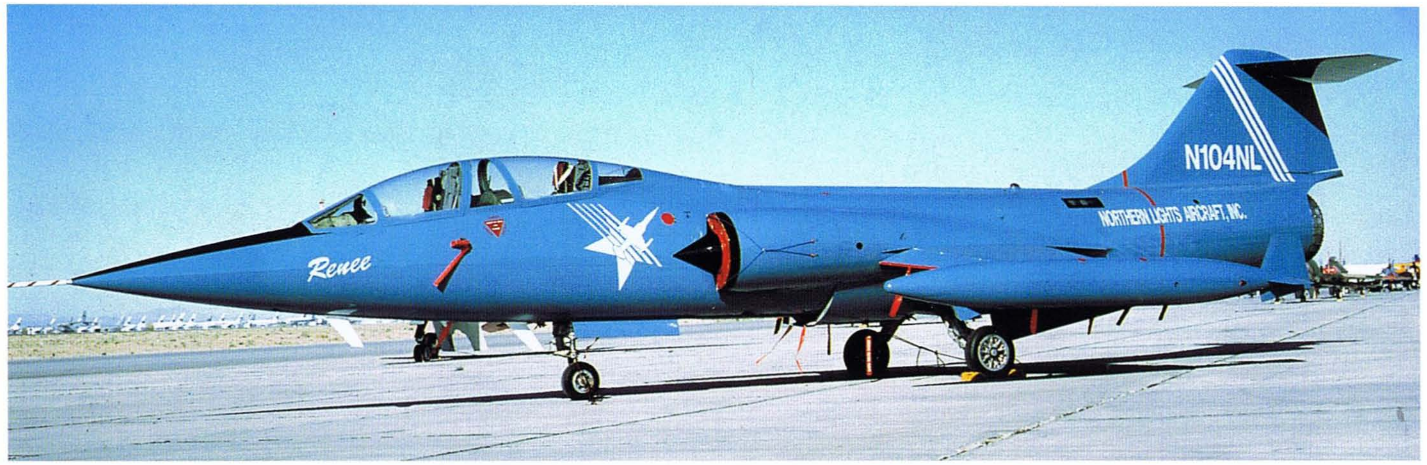
*(Middle)* F-104G 20+36 of JaboG32 'Boelcke'. This aircraft was built in 1961 and went to JaboG3, then flew with JaboG34. The blue and white colours are for the last flight of an F-104 with JaboG32 in 1984. This aircraft crashed shortly after, on 11 December 1984, at Niederpöring when the pilot became disorientated in cloud. Maj Hans-Dieter Kersten was killed. Hans Redemann via Matthias Vogelsang

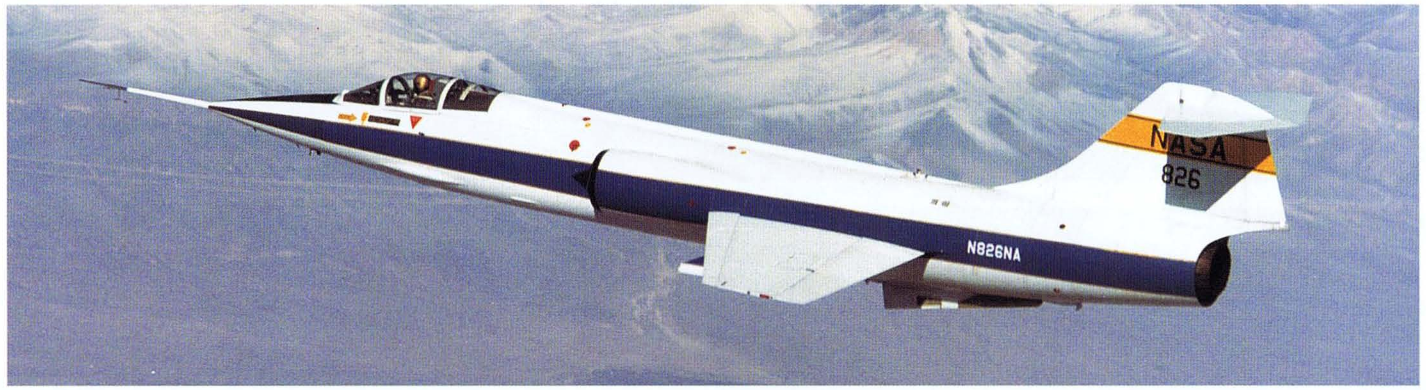
*(Bottom)* CF-104 104796 painted yellow and black stripes, of No.439 'Sabre Toothed Tiger' Squadron. CONAM

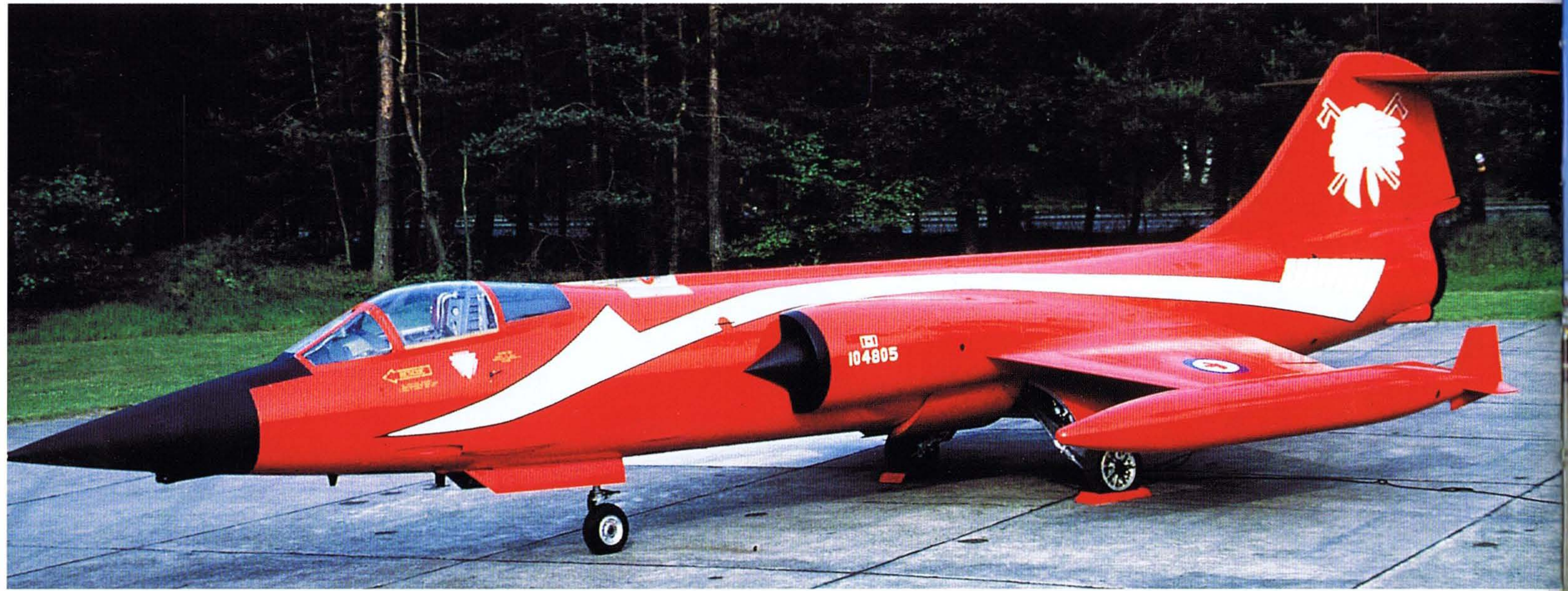
*(Top)* F-104G 25+50 of JaboG34 at Memmingen, Germany, painted to celebrate the unit's 25th anniversary of flying the Starfighter (which first began arriving on 1 July 1964). This aircraft first flew on 20 January 1965 and began service with JaboG32. CONAM

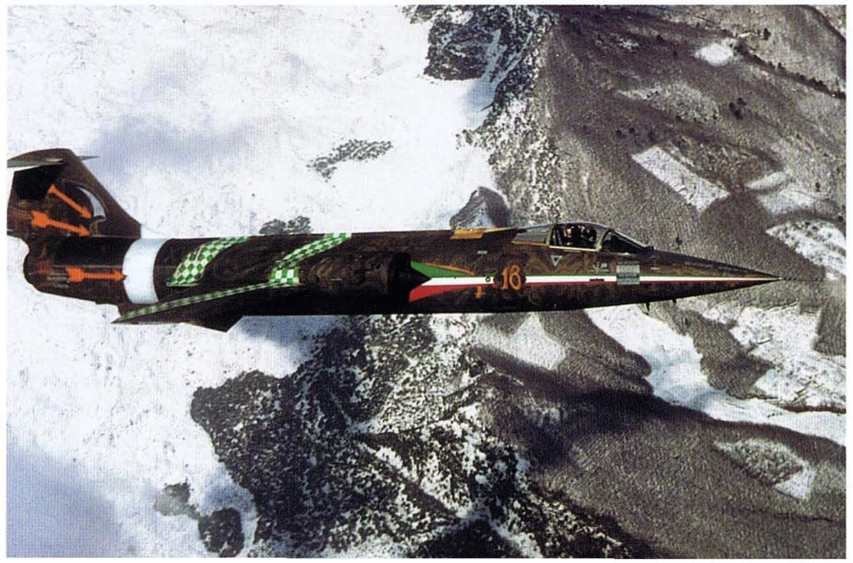
*(Middle)* All-blue TF-104G (WerkNr5961) 28+31 of JaboG31 'Boelcke' with Darryl Greenamyer's CF-104 N104RB Red Baron. 28+31 first flew on 20 November 1967 and served with JG74 and JaboG31. In 1983 28+31 was the 'Blue Boelcke 01' for the 25th anniversary of JaboG31. It last served with JaboG34 and was acquired by the Greek Air Force in November 1989. CONAM

*(Bottom)* Former RCAF CF-104RB N104RB Red Baron, which Darryl Greenamyer assembled with help from American Jet Industries, Inc. in Van Nuys, California, and which he used to set a world speed record over a 3km course at restricted altitude at Mud Lake near Tonopah, Nevada, on 24 October 1977. Red Baron reached an unofficial speed record of 988.26mph (1,591.1km/h) (because of a faulty recording instrument on the ground!) Greenamyer attempted the record again in February 1978 but Red Baron crashed. Greenamyer survived but N104RB was destroyed. CONAM









**(Top)** **TF-1-4G N104L Renée of Northern Lights Aircraft, Inc. Initially retained by Lockheed as a company demonstrator, this Starfighter was used by Jacqueline Cochran to set world speed records. It was then acquired by the KLu in May 1965 as D-5702, and from 25 August 1980 it was used by the Turkish Air Force.** CONAM

**(Upper middle)** **RF-104G-8213 N826NA (ex-24+64), which was acquired by NASA in July 1975, was used as a research platform and also as a support aircraft for other research missions, pictured in August 1980. 24+64 first flew on 30 January 1964 and with the** Luftwaffe **flew with AG52 before being modified to F-104G and flying with** JG74, **then** MFG1, **and also** WaSLw.10. **Its last flight for NASA was on 1 February 1994.** NASA/AFMC History Office

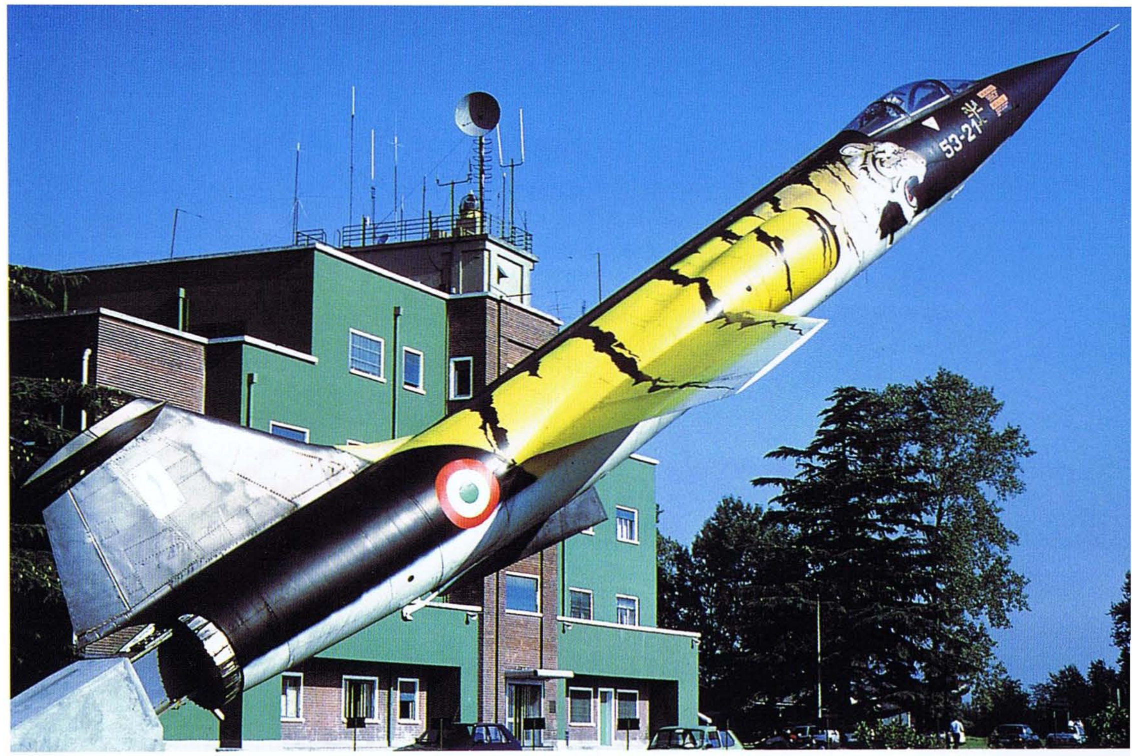
**(Above)** **CF-104D 104805 of No.421 'Red Indian' Squadron CAF.** CONAM

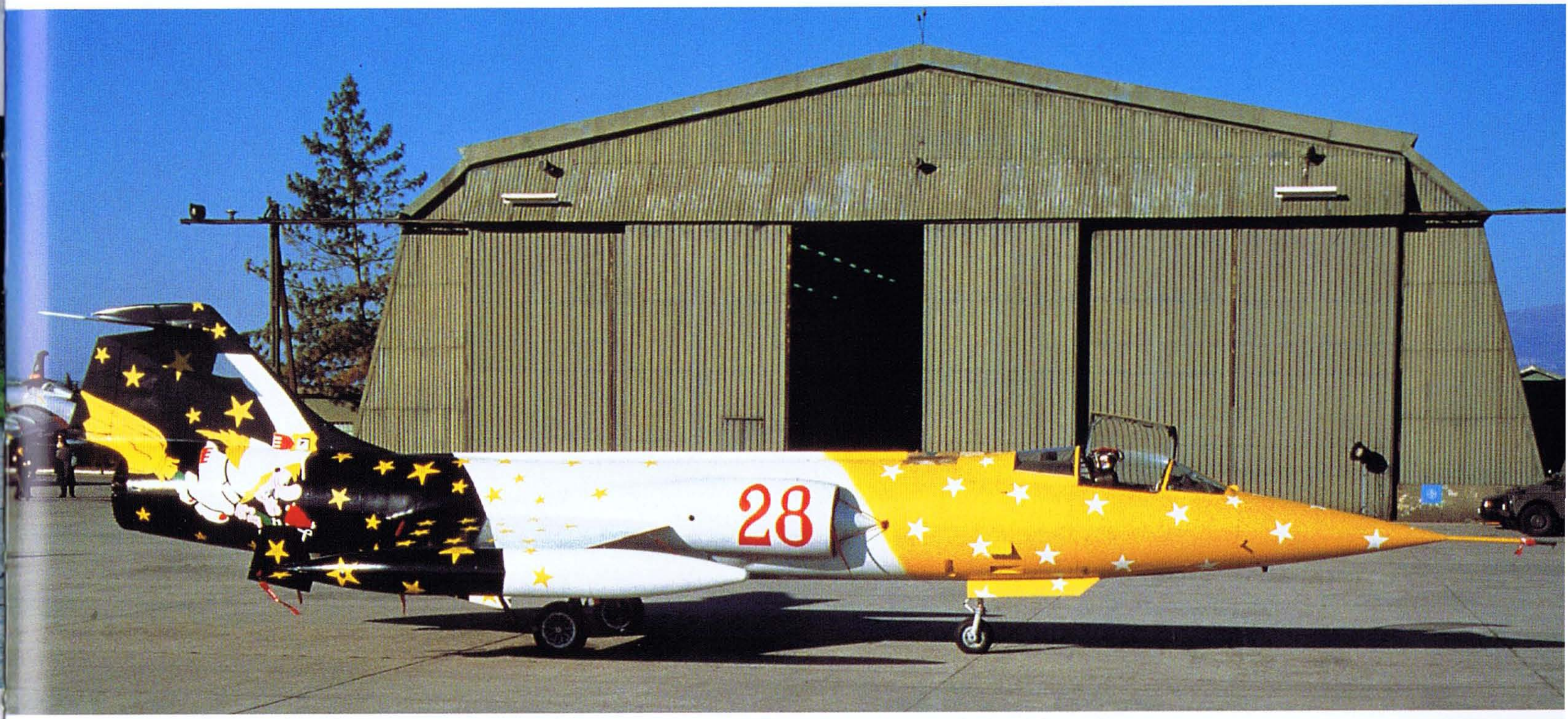
**F-104S ASA of** 37° Stormo 'Cesare Toschi', **18° Gruppo, of the** Aeronautica Militare Italiana (AMI), **based at Trapani-Birgi.**
Commandant 18° Gruppo

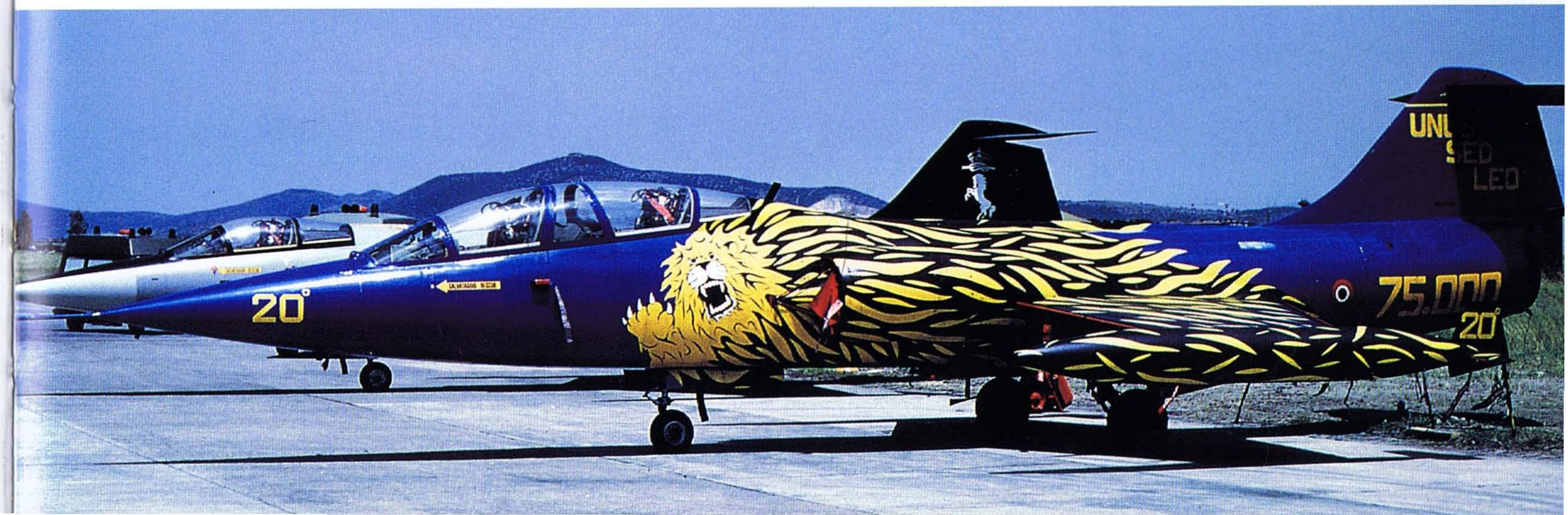
**After withdrawal from** Aeronautica Militare Italiana (AMI) **service, F-104G MM6825 53-06 was repainted as MM6504 53-21 in 'tiger' colours (painted for the 1988 Tiger Meet at Cameri) and placed on a pylon outside the base HQ at Cameri on the occasion of the 50th anniversary of** 53° Stormo 'Gugliemo Chiarini' **in 1987.** Mick Jennings

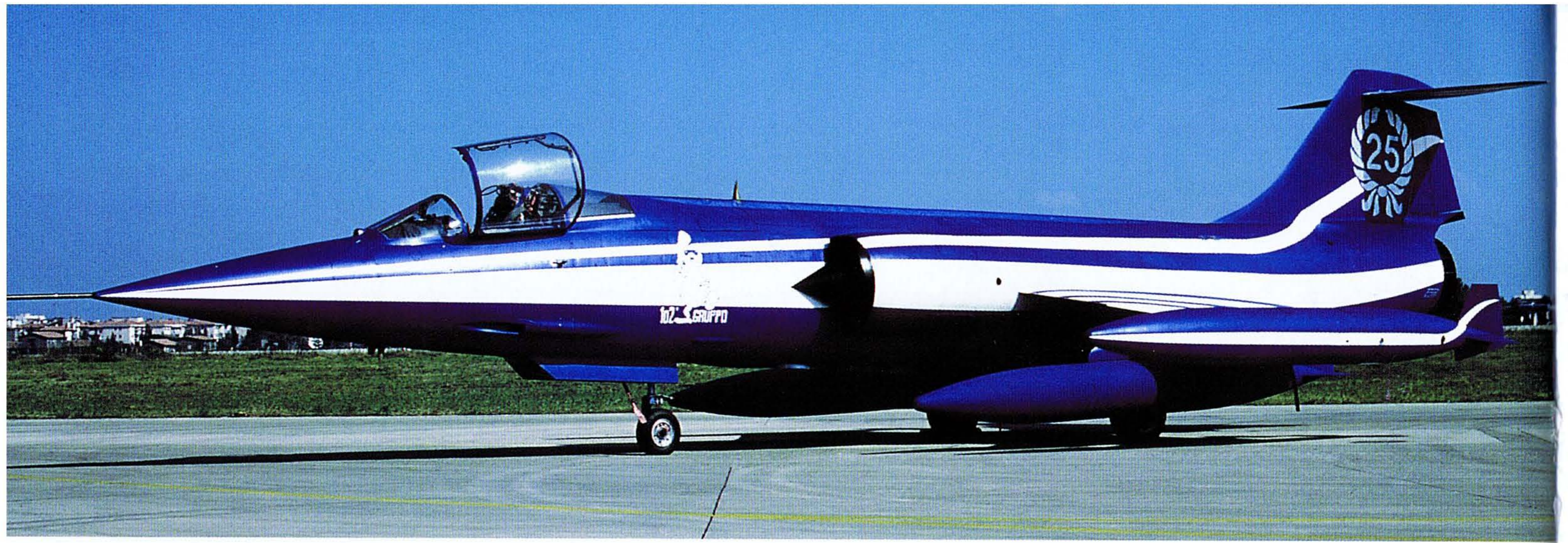
**(Below)** **The white, yellow, and black scheme with the Strega (witch) on the tail of F-104G MM6579 (ex 3-42) of** 28° Gruppo, 3° Stormo 'Carlo Emanuele Buscaglia' **of the** Aeronautica Militare Italiana (AMI) **was applied for the reunion at Verona-Villafranca of 2 December 1989.** Via Matthias Vogelsang

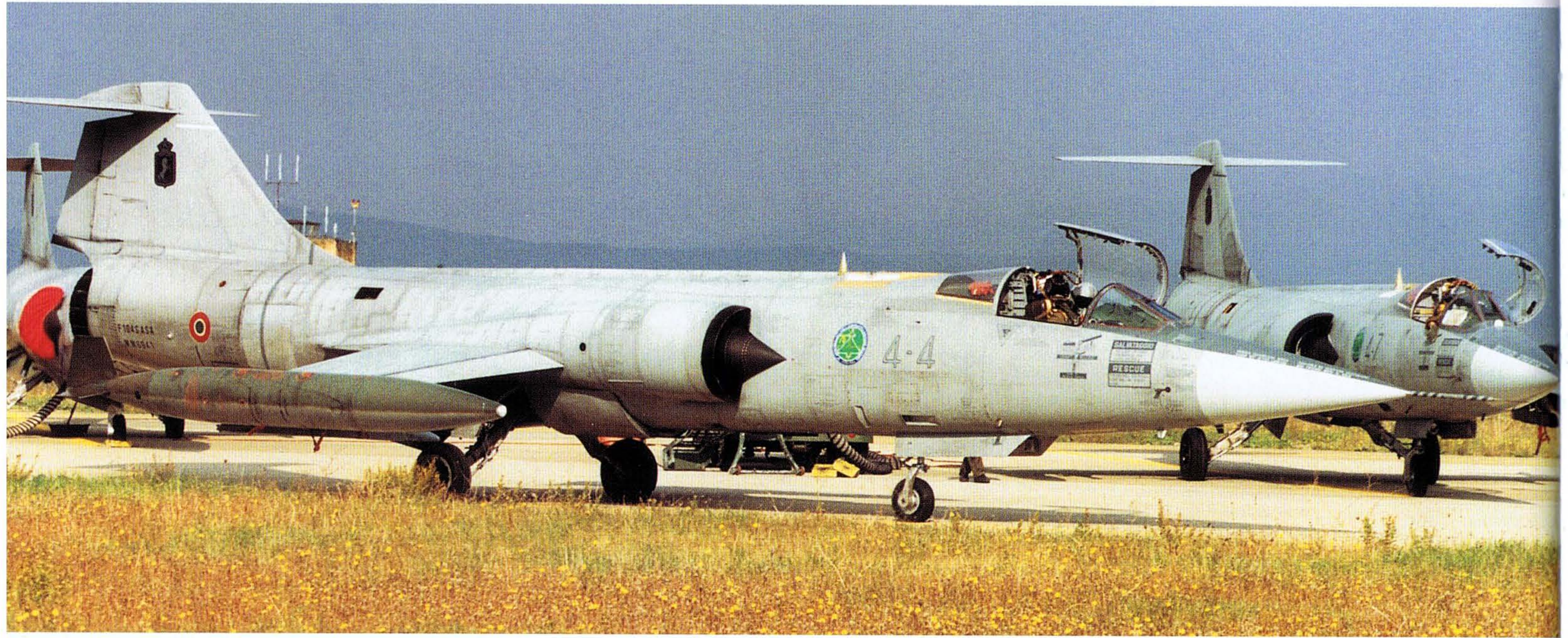
**(Bottom)** **In April 1991 the** 20° Gruppo, 4° Stormo 'Amendo d'Aosta' **(motto:** Unus Sed Leo **– hence the lion) passed the 75,000hr on the Starfighter and for the occasion, TF-104G MM54258 received these colours, which it retained for some months.** CONAM

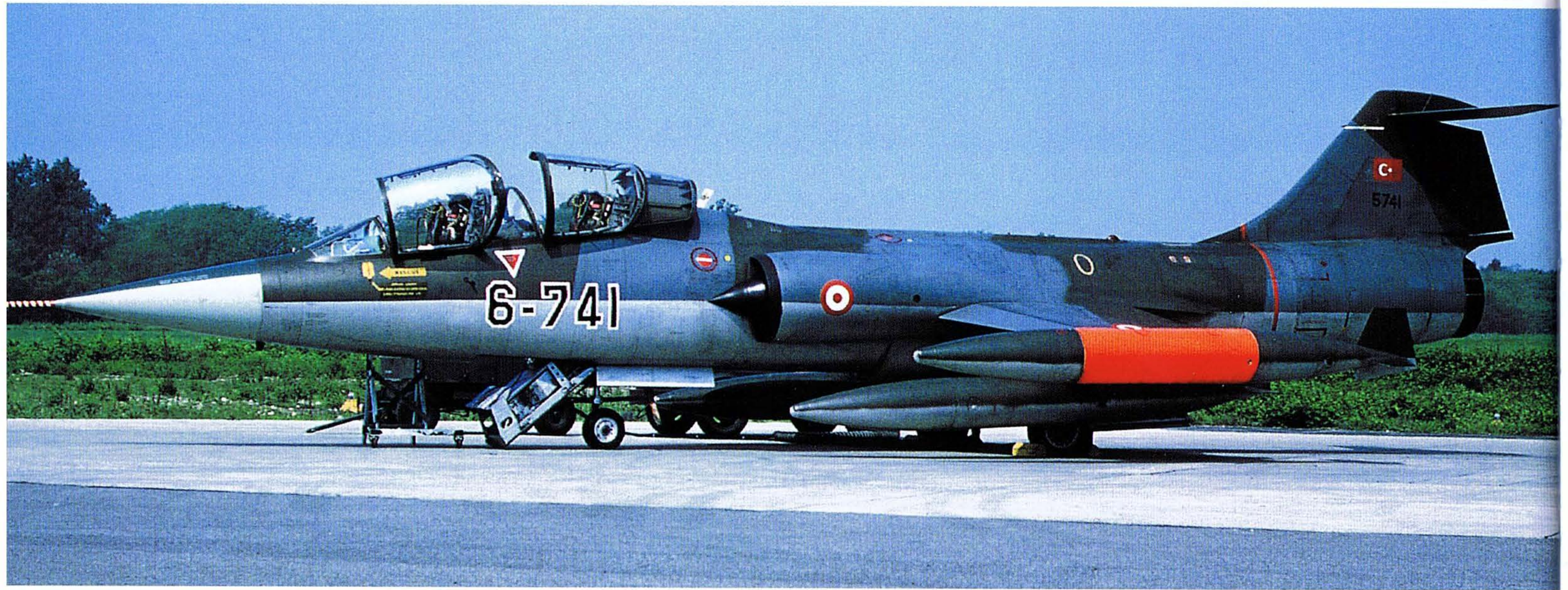












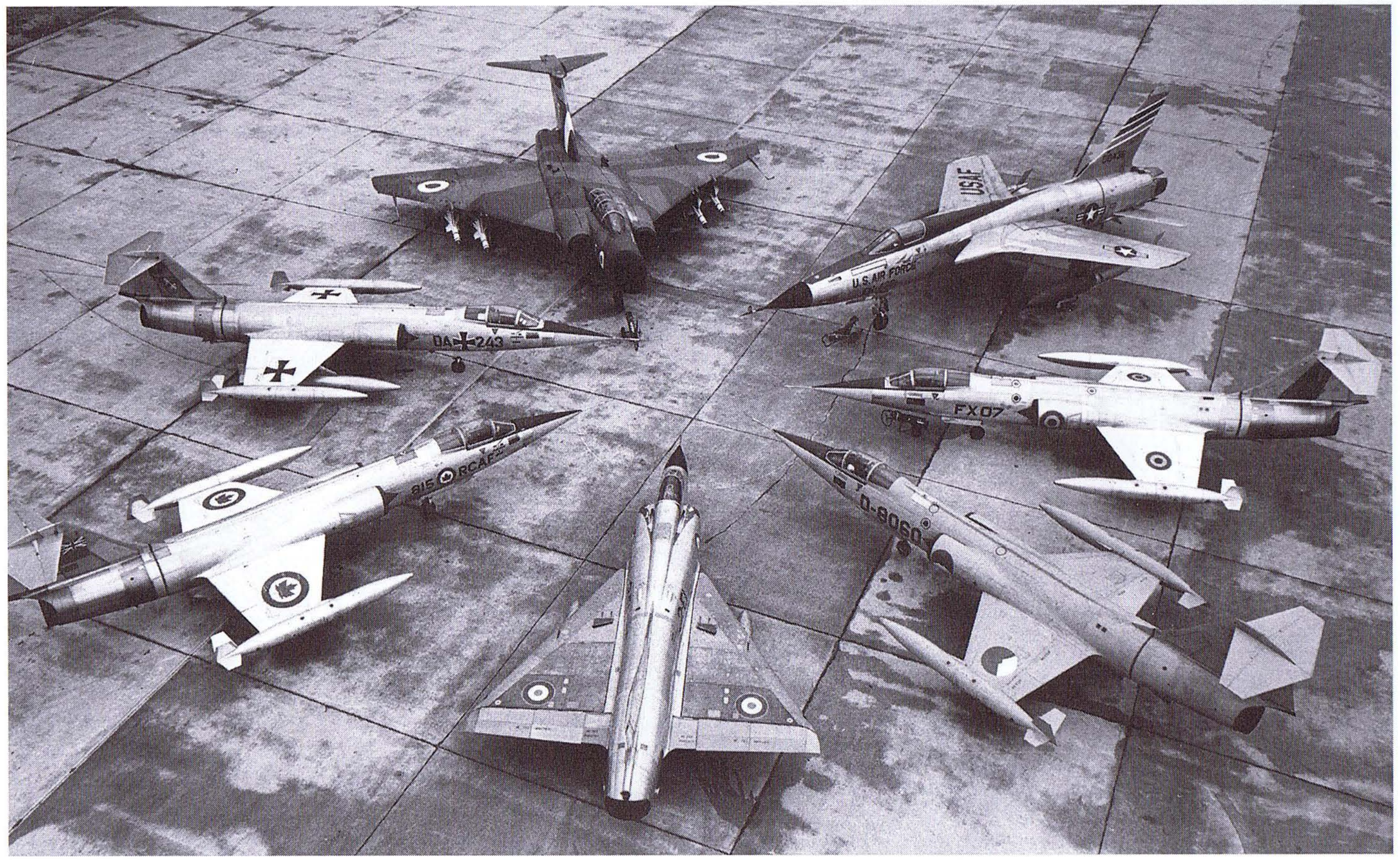
***(Top)* In 1998 F-104S MM6833 of** 102° Gruppo, 5° Stormo 'Giuseppe Cenni' **was painted all blue to celebrate 25 years of Starfighter operations with** 102° Gruppo **(which received the F-104S in March 1973). The white** Papero **('combat duck') in the centre of the fuselage is the unit badge.** CONAM

***(Middle)* F-104S ASA MM6941 –4 and –7 (behind) of** 4° Stormo 'Amendo d'Aosta' **of the** Aeronautica Militare Italiana (AMI) **at Grosseto.** Mick Jennings

***(Bottom)* TF-104G 6-741 of the 6th Wing,** Türk Hava Kuvvetleri (THK, **Turkish Air Force).** CONAM

CHAPTER FIVE

# NATO Operators



**Starfighters of NATO nations, together with jet fighters of RAF Germany, USAF, and France. From top: USAF F-105D Thunderchief 00436 of the 36th Tactical Fighter Wing at Bitburg, Germany; RAF Gloster Javelin FAW.7 XH771/F;** Koninklijke Luchtmacht (KLu, **Royal Netherlands Air Force); F-104G D-8060 (which was acquired by the** Türk Hava Kuvvetleri (THK, **Turkish Air Force) in January 1982; RCAF CF-104 12815;** Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu) **FX-07 (which was acquired by the RoCAF (Taiwan) in 1990);** Luftwaffe **F-104G DA+243 of** JaboG31 **'Boelcke' and** French Armée de l'Air **Mirage IIIE 2-EI.** NATO

## Belgium

Beginning in February 1963 the *Force Aérienne Belge (FAé)/Belgische Luchtmacht BLu)* received a total of 100 SABCA-built F-104Gs, and twelve Lockheed-built TF-104Gs. These aircraft were assigned to four *escadrilles/smaldeels* (squadrons, or *ème*): the *349ème* and *350ème* of the *1 Wing de Chasse/1 Jachtwing* at Beauvechain/Bevekom, and the *23ème* and *31ème* of the *10 Wing Chasseurs-Bombardiers/10 Wing Jager-Bommenserpers* at Kleine Brogel, for tactical strike, and all-weather air defence, respectively. Altogether, the Belgian Air Force lost forty Starfighters and twenty-three pilots killed.

*1 Wing de Chasse/1 Jachtwing* began replacing its CF-100 Canucks with the Starfighter in 1963 and *10 Wing Chasseurs-Bombardiers/10 Wing Jager-Bommenwerpers* received F-104Gs for the strike-attack role a year later. During the 1980s the Beauvechain and Kleine Brogel *èmes* converted to the General Dynamics F-16A/B. The *349ème* received its first F-16B on 26 January 1979 and the *ème* was declared operational in January 1981. *350ème* began conversion to the F-16 in July 1980 and was declared operational on the Fighting Falcon in the summer of 1981. The Kleine Brogel units meanwhile, retired the last of their Starfighters in September 1983.

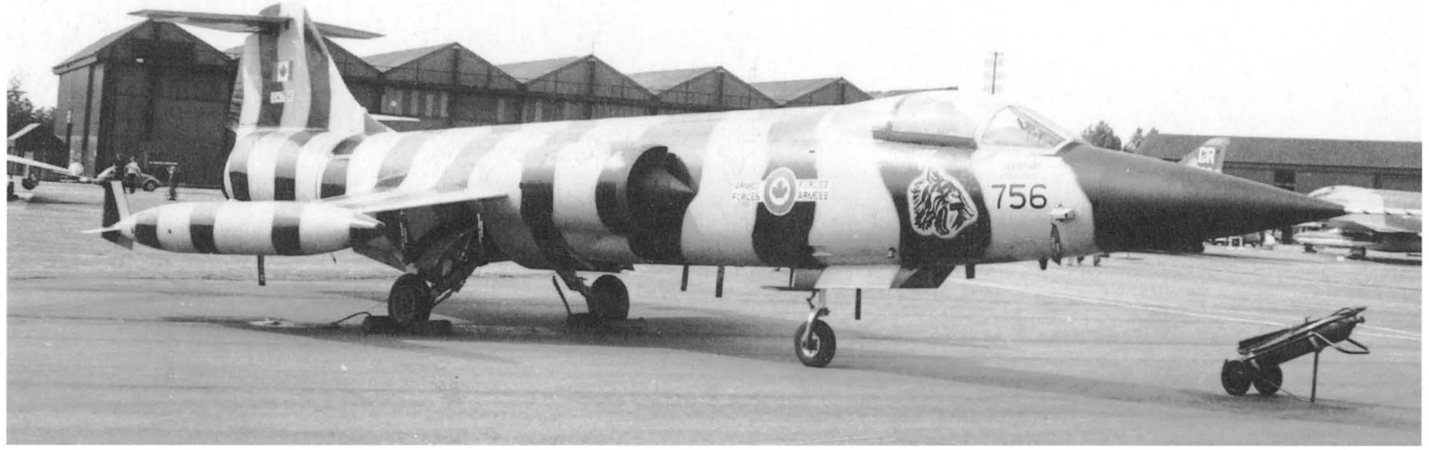
**F-104G FX-40 of the** Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu). **This Starfighter was TOC at Gosselies on 25 August 1964 and it was issued to** 350ème/1W. **After completing Belgian service in 1981, FX-40 was one of several acquired by** Türk Hava Kuvvetleri (THK, **Turkish Air Force) and was renumbered '083'.** BLu

*23ème* received its first F-16s in December 1981, being declared operational on the Fighting Falcon in March 1983. *31ème* became operational on the F-16 in 1984.

## Canada

On 2 July 1959, it was announced in Ottawa that the Canadair-built CF-104 had been selected to replace the Canadair Sabre Mk.6, which was suffering from a growing number of fatigue problems, and the Avro Canada CF-100 Canuck, in the eight squadrons of the 1st Air Division based in France and Germany. The Starfighter had faced stiff competition, from the Grumman F-11 Super Tiger, Hawker Siddeley Buccaneer S-2, Dassault Mirage IIIC, the Fiat G.91, the Northrop F-5A, and the Republic F-105 Thunderchief. The Royal Canadian Air Force (Canadian Armed Forces from 28 February 1968 by consolidating the Army, Navy and Air Force) ultimately received 200 CF-104s and 38 CF-104Ds. Replacement marked a change of role from air defence to nuclear strike. Operating in the strike role, the CF-104 carried a single high-yield tactical nuclear weapon on the centreline. This weapon could have been delivered using a LABS toss manoeuvre, or in a low-level laydown attack.

**CF-104 12702, the second of 200 Canadair-built CF-104 Starfighters taxies in with its Irvin braking parachute deployed.** via Philip Jarrett



**CF-104 12756 No. 439 'Sabre Toothed Tiger' in Tiger scheme striping.** via Philip Jarrett

The very early Canadian Starfighter pilots were trained in the US, until in July 1961 the No. 6 (Strike and Reconnaissance) OUT at Cold Lake, Alberta, became the first Canadian unit to receive CF-104/CF-104D Starfighters. (No.6 OUT was redesignated No.417 Squadron on 23 March 1968.) In Europe CF-104/CF-104Ds were used to equip eight squadrons of No.1 Air Division, beginning in December 1962 with No.427 'Lion' Squadron, No3 Wing, at Zweibrücken, Germany. The two other squadrons in No.3 Wing – Nos. 430 and 434, were also re-equipped with the CF-104. Re-equipment of the two Sabre Mk.6 squadrons in No.4 Wing at Baden-Söllingen – Nos.422, and 444 Squadrons – was also well advanced early in 1963. The first six Starfighters for No.421 'Red Indian' Squadron of No.1 Wing arrived at Grostenquin, France, on 6 November 1963. The last RCAF Sabres in Europe were retired on 14 November 1963, when No.439 'Sabre Toothed Tiger' Squadron at Marville, stood down.

On 5 February 1964 French bases had to be evacuated following the French–US disagreement on the storage of nuclear weapons. When Grostenquin closed during the year, No.421 Squadron joined No.4 Wing at Baden-Söllingen, and No.430 joined No.3 Wing at Zweibrücken. By March 1964 the Starfighter also equipped No.439 'Sabre Toothed Tiger' and No.441 'Silver Fox' Squadrons of No.1 Wing at Marville, France. These two squadrons were designated in the photo-reconnaissance role, but they could also be used as strike fighters with conventional weapons. In 1967 Marville too had to be evacuated as part of the French withdrawal from NATO command. Nos.1 and 3 Wings in Germany absorbed the Starfighters of No.439 and No.441 Squadrons, which re-located to Lahr. After the Canadian government's rejection of the nuclear role in 1968, CF-104s were assigned to conventional ground attack and in 1974 the M-61 cannon was installed.

On 31 March 1967 Nos.434 Squadron at Zweibrücken, and No.444 Squadron Baden-Söllingen were disbanded. Nos.421 and 422 Squadrons at Baden-Söllingen continued as No.4 Wing until 1970. Meanwhile, in June 1969 Zweibrücken closed and No.427 Squadron moved from No.3 Wing to join No.4 Wing at Baden-Söllingen, while No.430 moved to Lahr.

**Specification – Canadair CF-104**

| | |
|---|---|
| Model: | (formerly CF-111/CL-90) |
| Type: | (CF-104) all-weather, multi-role fighter; (CF-104D) trainer |
| Crew: | (CF-104) Pilot only; (CF-104D) Two |
| First Flight: | 26 May 1961 |
| Number built: | (CF-104) 200; (CF-104D) 38 |
| Powerplant: | One 10,000lb (4,536kg) static thrust, 15,800lb (7,167kg) afterburning Canadian-built Orenda J79-OEL-7 turbojet |
| Dimensions: | Span, without tip tanks, 21ft 9in (6.62m); wing area, 196.1sq ft (18.21m²); length, 54 ft 8in (16.66m); height, 13ft 5in (4.08m) |
| Empty weight: | 13,996lb (6,348kg) |
| Combat weight: | 20,640lb (9,362kg) |
| Max take-off weight: | 29,038lb (13,172kg) |
| Performance: | Max speed, 1,146mph (1,844km/h) at 50,000ft (15,240m)<br>1,328mph (2,137km/h) at 35,000ft (10,670m)<br>Cruising speed, 510mph (821km/h)<br>Climb in one minute, 48,000ft (14,630m)<br>Service ceiling, 50,000ft (15,240m)<br>Absolute ceiling, 90,000ft (27,430m)<br>Range, 1,080 miles (1,738km)<br>Maximum range, 1,630 miles (2,623km) |
| Fuel: | Normal, 897 USgal (3,395l) |
| Armament: | One 20mm M-61 Vulcan rotary cannon, four AAM missiles, 4000lb (1,814kg) bombs |

**CF-104 12881, 12820 and 12885 of the RCAF at Baden-Söllingen, Germany.** Andy Graham via Steven M. Fochuk

In the summer of 1970 Nos. 421, 422, 427, and 430 Squadrons were disbanded. No.439 and No.441 Squadrons at Lahr meanwhile, relocated to Baden-Söllingen.

Beginning in 1983, the remaining CAF Starfighters were replaced with the McDonnell Douglas CF-18 Hornet. No.439 Squadron was stood down on 1 July 1983, the last CF-104s being phased out of service by No.441 Squadron at Baden- Söllingen on 1 March 1986. Thirty-seven Canadian CF-104 pilots lost their lives.

**Canadair CF/F-104 Starfighter Production**

| *Serials* | *Type* | *Quantity* | *Operator* |
|---|---|---|---|
| 12701/12900 | CF-104 | 200 | RCAF/CAF |
| 62-12302/12349 | F-104G | 48 | MAP |
| 62-12697/12734 | F-104G | 38 | MAP |
| 63-13638/13647 | F-104G | 10 | MAP |
| 64-17752/17795 | F-104G | 44 | MAP |

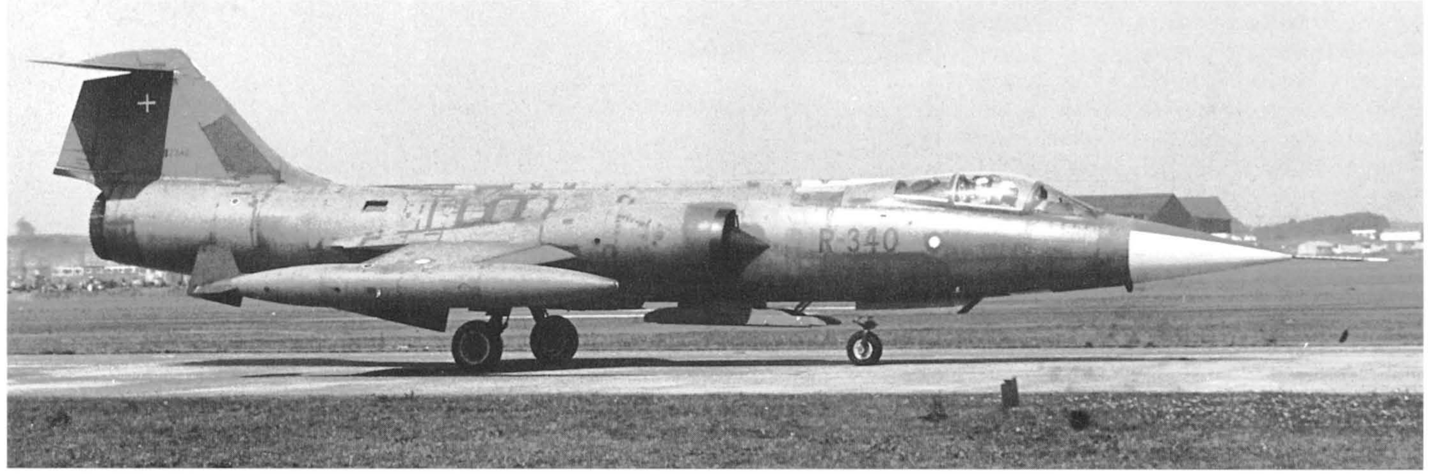
## Denmark

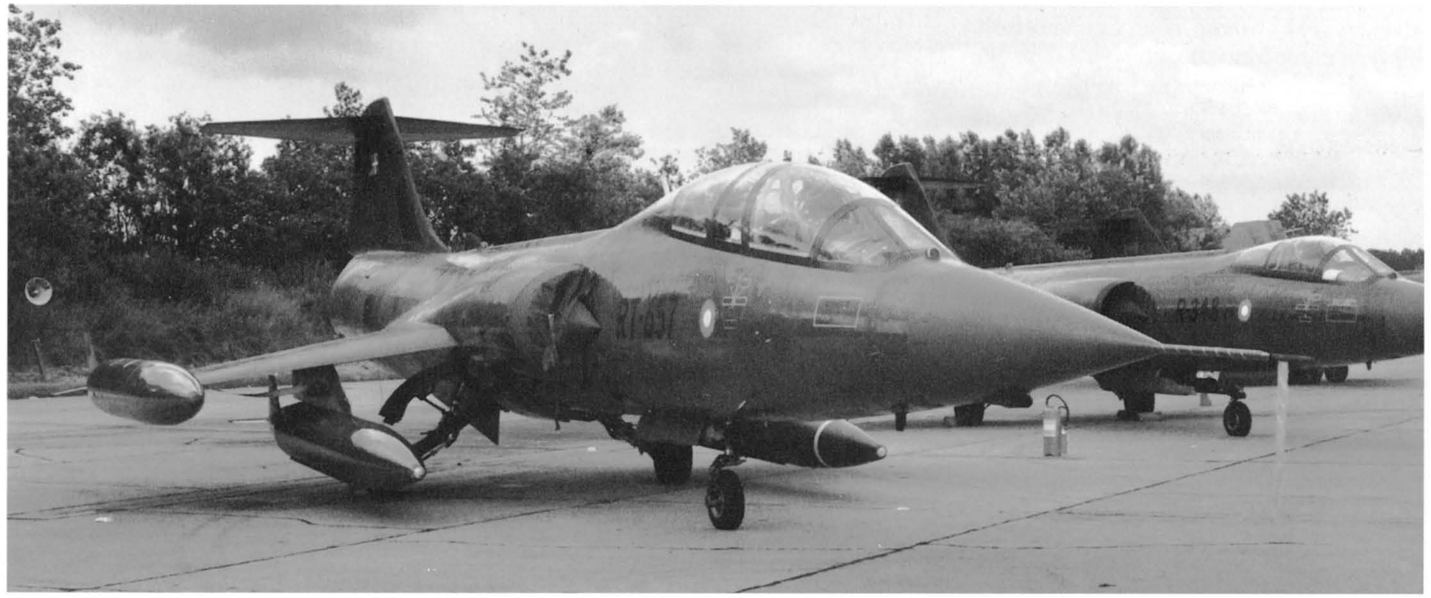
Beginning in November 1964, *Kongelide Danske Flyvevâbnet* (KDF, Royal Danish Air Force) received twenty-five Canadair-built F-104Gs and four Lockheed TF-104Gs to equip two *eskadrilles* (squadrons) (*Esk 723* and *Esk 726*) at Aalbørg. *Esk 726* was the first of the two units to equip with the F-104G when it began replacing its F-86D Sabres in December 1964. *Esk 723* began replacing its F-86D Sabres in January 1965. The first ten Starfighters were delivered to Aalbørg in a complicated operation that involved taking the F-104s on loaders through streets nearby after they had been offloaded at the docks. The remaining Starfighters followed in two more consignments, in December 1964, and in June 1965.

In 1972–74 twenty-two ex-Canadian Starfighters (fifteen CF-104s and seven CF-104Ds, with the latter being specially modified for use by *Esk 726* in the electronic countermeasures role), were transferred to Denmark. On 1 January 1983 *Esk 723* split into *Esk 723-104* and *723-16*, the latter transferring to Skrydstrup to receive the F-16. *Esk 723-104* disbanded as a Starfighter squadron on 1 January 1984, and the new *Esk 723* returned to Aalbørg on 30 March as the KDF's third operational F-16 unit. Some of *Esk 723*'s Starfighters were withdrawn from service in November 1984, although one later returned to temporary service. On 30 April 1986 *Esk 726* was disbanded and, with the exception of four aircraft temporarily retained for target-towing duty, the Starfighters were retired from Danish service.

***(Below)*** Kongelide Danske Flyvevåbnet (KDF**, Royal Danish Air Force) F-104G R-340 taxiing at Prestwick on 27 July 1971.** Gordon Brown via *Aeroplane*

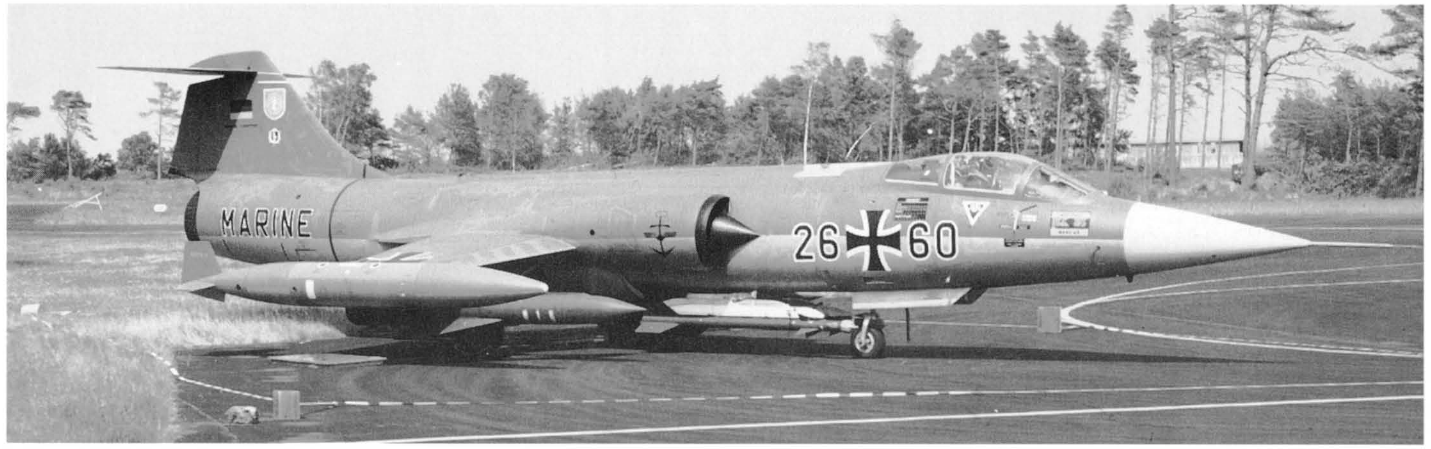
***(Bottom)*** Kongelide Danske Flyvevåbnet (KDF**, Royal Danish Air Force) TF-104G RT-657 and R-348 at the Open Day at Leeuwarden, The Netherlands, on 22 June 1985.** Peter Luickhardt via Matthias Vogelsang

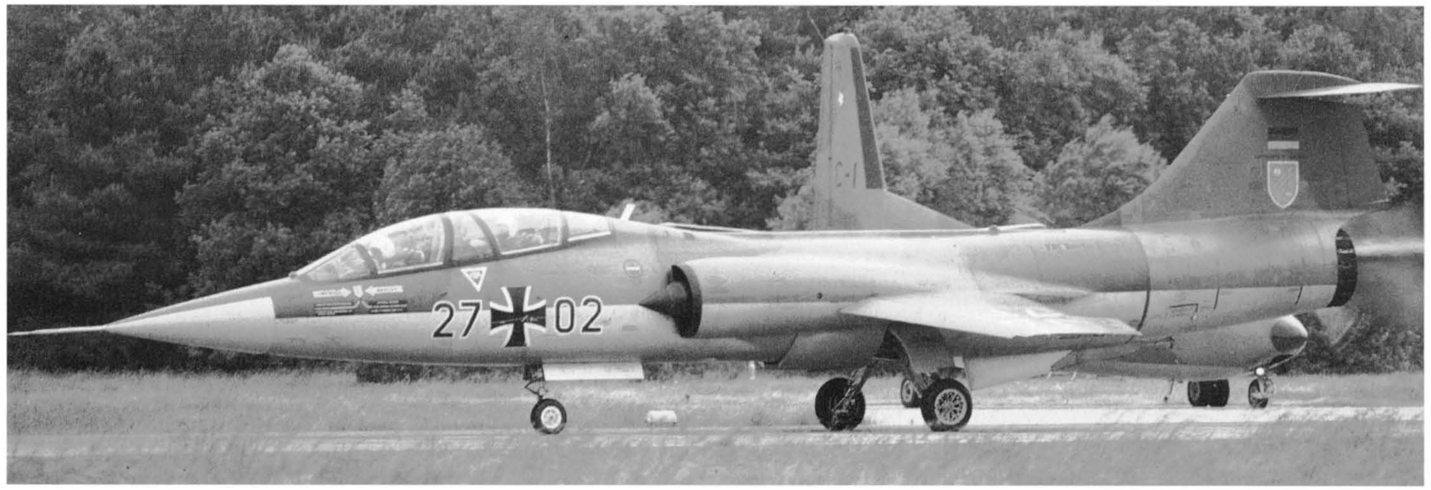




## Germany

The first German Starfighters were F-104Fs, which were used initially at Luke AFB, Arizona, and George AFB, California, attached to the 4512th, 4518th and 4443rd Training Squadrons of the 58th Training Wing to





***(Top)*** **F-104G 26+60 of MFG2 of the** Marineflieger **(West German Navy) at Nordholz on 8 July 1984 during the 25th anniversary of the F-104 celebrations. 26+60 first flew on 22 October 1971 and was issued to** MFG1**. Today this Starfighter is used for training purposes at** WTD.61. Matthias Vogelsang

***(Above)*** **TF-104G 27+02 of** Waffenschule.10 **of the** Luftwaffe **at Jever in 1982. This two-seater was built in 1962 and first flew with** Waffenschule der Luftwaffe 10**, before it was transferred to** JaboG34. **Acquired by the** Türk Hava Kuvvetleri (THK**, Turkish Air Force) in 1985, it last flew as 9-703 with 9.AHU at Balikesir.** Matthias Vogelsang

**F-104G XG+292 of the** Luftwaffe **taxiing in past F-104G D-8267 of No.311 Squadron of the** Koninklijke Luchtmacht (KLu**, Royal Netherlands Air Force). D-8267 crashed at Bremen, Germany, on 20 September 1971.** Via GMS

train a cadre of instructors, and later pilots and ground crews. Training of F-104 pilots in the USA ended in March 1983 when the *Luftwaffe* Starfighters were withdrawn from service with the USAF's 69th TFS, 405th Tactical Training Wing and the Starfighters were handed over to *Waffenschule 10 (WS10)* at Norvenich.

In all, Germany received a total of 915 Starfighters. These were made up as follows: 30 F-104Fs, 96 F-104Gs and 136 TF-104Gs from Lockheed; 255 F/RF-104Gs from the North Group, 210 F-104Gs from the South Group, 88 F-104Gs from the West Group, 50 F/RF-104Gs from the Italian Group, and 50 F-104Gs from MBB. All told, Germany lost 281 Starfighters.

### Luftwaffe *and* Marineflieger *Service*

(*See* Chapter 3.)

## Greece

Deliveries to the *Elliniki Vassiliki Aeroporia* (Royal Hellenic Air Force) at Hellas of Canadair/Lockheed-built F-104G/TF-104Gs, began in March–April 1964 under the terms of the Military Defense Assistance Program (MAP). These aircraft were taken on the inventory of the *114 Ptérix Mahis* (Combat Wing) for operation by one (later two) *Dioseos Bombardismoy mire* (fighter-bomber squadrons), *335 Mira* 'Tiger' and *336 Mira* 'Olympus'. *335 Mira*, at Tanagra, became the first Greek Starfighter squadron, in April 1964. From December 1964 to February 1965, 19 Canadair-built F-104Gs were obtained by HAF and formed *336 Mira*, based temporarily at Tanagra, in January 1965. This brought the number of Lockheed- and Canadair-built Starfighters supplied through MAP in 1964 to forty-four F-104Gs and six TF-104Gs. In 1972, nine more F-104Gs and one TF-104G, all previously operated by the *Ejercito del Aire*, were received.

On 21 December 1966 *336 Mira* was relocated at Araxos Air Base (*116 Ptérix Mahis*) and became 336 Strike Squadron. *335 Mira* of the 114 *Ptérix Mahis* remained at Tanagra Air Base until June 1977, when it moved to Araxos having retired the last of its F-104G/TF-104Gs and converting to the Mirage F1.

***Elliniki Vassiliki Aeroporia* (Royal Hellenic Air Force)**

*F-104G, RF-104G, TF-104G Serial Numbers*

| | |
|---|---|
| 1. MAP F-104G:<br>(Military Assistance Program) | 61-2601, 61-2609, 6161-2624, 62-12302, 62-12303, 62-12304, 62-12305, 62-12306, 62-12307, 62-12308, 62-12309, 62-12310, 62-12311, 62-12313, 62-12314,62-12315, 62-12317, 62-12318, 62-12319, 62-12321, 62-12697, 62-12705, 62-12706, 62-12708, 63-12704, 63-12709, 63-12710, 63-12711, 63-12712, 63-12713, 63-12714, 63-12715, 63-12717, 63-12719, 63-12720, 63-12721, 63-12722, 63-12723, 63-12724, 63-12725, 63-12726, 63-12727, 63-12729, 63-12730, 63-12734, 63-13638, 63-13639, 63-13643, 64-17780, 64-17781, 64-17782, 64-17787, 64-17788. Nine of these were donated by Spain in 1972. |
| 2. MAP TF-104G: | 61-3025, 62-12267, 62-12272, 62-12273, 62-12274, 62-12278. One of these donated by Spain in 1972. |
| 3. From Netherlands: | 6666, 6668, 6670, 6680, 6681, 6684, 6695, 6697, 6699, 6700. |
| 4. From Germany<br>F-104G (CONSORTIUM): | 7057, 7073, 7080, 7081, 7082, 7083, 7087, 7088, 7090, 7094, 7097, 7106, 7107, 7149, 7151, 7152, 7153, 7155, 7156, 7163, 7165, 7166, 7167, 7168, 7172, 7175, 7176, 7180, 7183, 7195, 7201, 7203, 7205, 7206, 7207, 7409, 7415, 7420, 7421, 7422, 7424, 7425, 7426, 7427, 7428, 7429, 7433, 7434, 7435, 8170, 8176, 8229. |
| RF-104G (CONSORTIUM): | 6629, 6639, 6642, 6662, 6664, 6665, 6672, 6674, 6676, 6677, 6678, 6679, 6690, 6691, 6692, 6693. |
| TF-104G (CONSORTIUM): | 5708, 5712, 5714, 5715, 5717, 5719, 5733, 5736, 5760, 5777, 5906, 5908, 5909, 5910, 5912, 5916, 5917, 5953, 5954, 5958, 5959, 5965. |

**F-104G FG-730 (MAP 63-12730) of the** Elliniki Vassiliki Aeroporia. **Deliveries of 35 F-104Gs to the Royal Hellenic Air Force began in 1965. Greece also received four TF-104Gs, and later nineteen F-104Gs and six TF-104Gs transferred from the USAF, Spain and Germany.** HAF

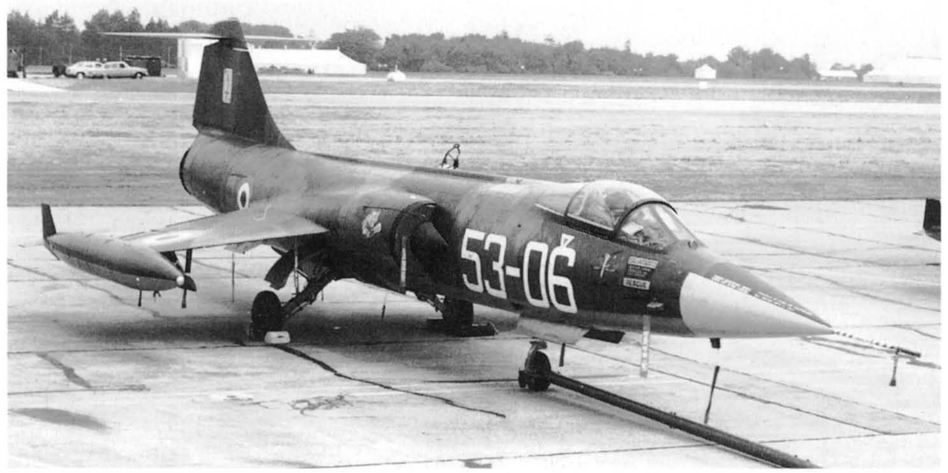
**TF-104G 22278 (MAP 62-12278) of the** Elliniki Vassiliki Aeroporia **(Royal Hellenic Air Force).** HAF

During 1981–82 *Elliniki Vassiliki Aeroporia* acquired another one hundred Starfighters (52 F-104Gs, 16 RF-104Gs and 22 TF-104Gs from Germany, and, in May and July 1982, ten Fiat-built F-104Gs from the *Koninklijke Luchtmacht* (*KLu*, Royal Netherlands Air Force). Altogether, HAF operated 159 Starfighters. They completed 224,489 hours of flight in a period of twenty-nine years, from spring 1964 until spring 1993, while sixteen pilots were killed. *336 Mira* of the *116 Ptérix Mahis* at Araxos retired its last F-104G/TF-104G Starfighters in spring 1993.

## Italy

The *Aeronautica Militare Italiana* (AMI) received a total of 124 Fiat-built F-104Gs with which to equip its Starfighter *gruppi* (squadrons). The *gruppi* are organized into a *stormo*, or wing). In turn, 24 TF-104Gs (twelve built by Lockheed and twelve co-produced) were also received by the AMI. Initially, the F/RF-104 Starfighter equipped four *CI* (*Caccia* (Fighter/Interceptor)/*CB* (*Caccia-bombardiere*, or fighter-bomber) *gruppi*, and two *ricognizione* (reconnaissance) *gruppi*. (Although the *101° Gruppo CBR* of the *8° Stormo* 'Gino Priolo' at Cervia-San Giorgio received its first F-104G Starfighters in December 1964, the

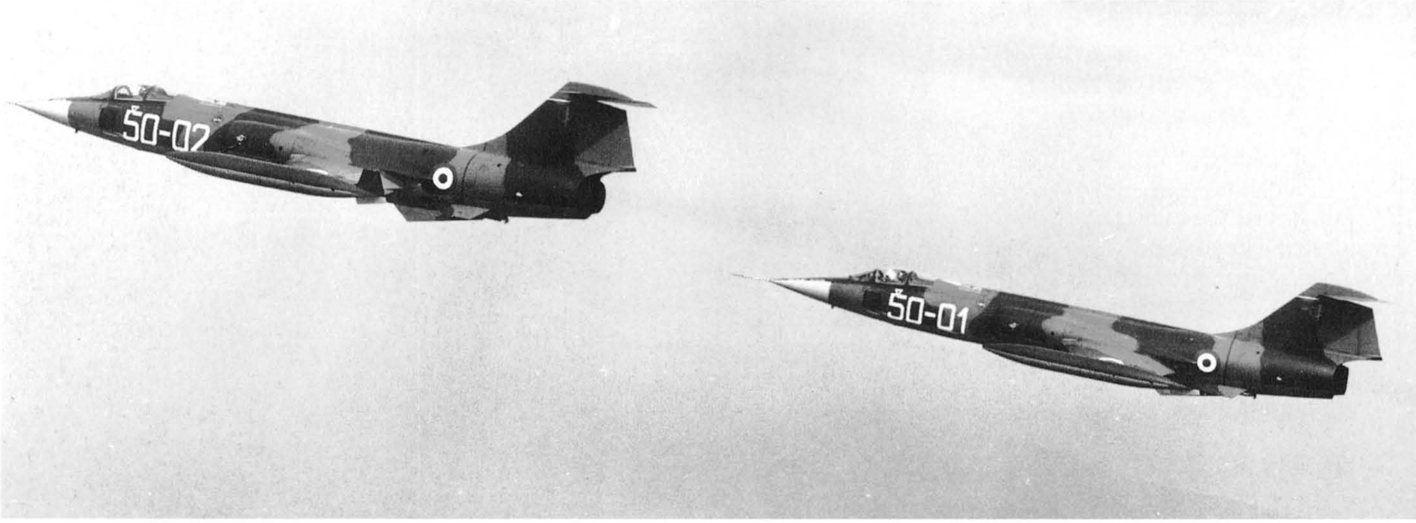
**First F-104S for the** Aeronautica Militare Italiana (AMI) **(5-41 of** 5° Stormo 'Giuseppe Cenni'**). Beginning in 1968** AMI **began receiving the F-104S, the final version of the Starfighter. The first Lockheed-modified F-104S advanced all-purpose Starfighter was flown in December 1966 and Fiat-built 246 F-104Ss for the AMI and the** Türk Hava Kuvvetleri (THK, **Turkish Air Force**). Lockheed

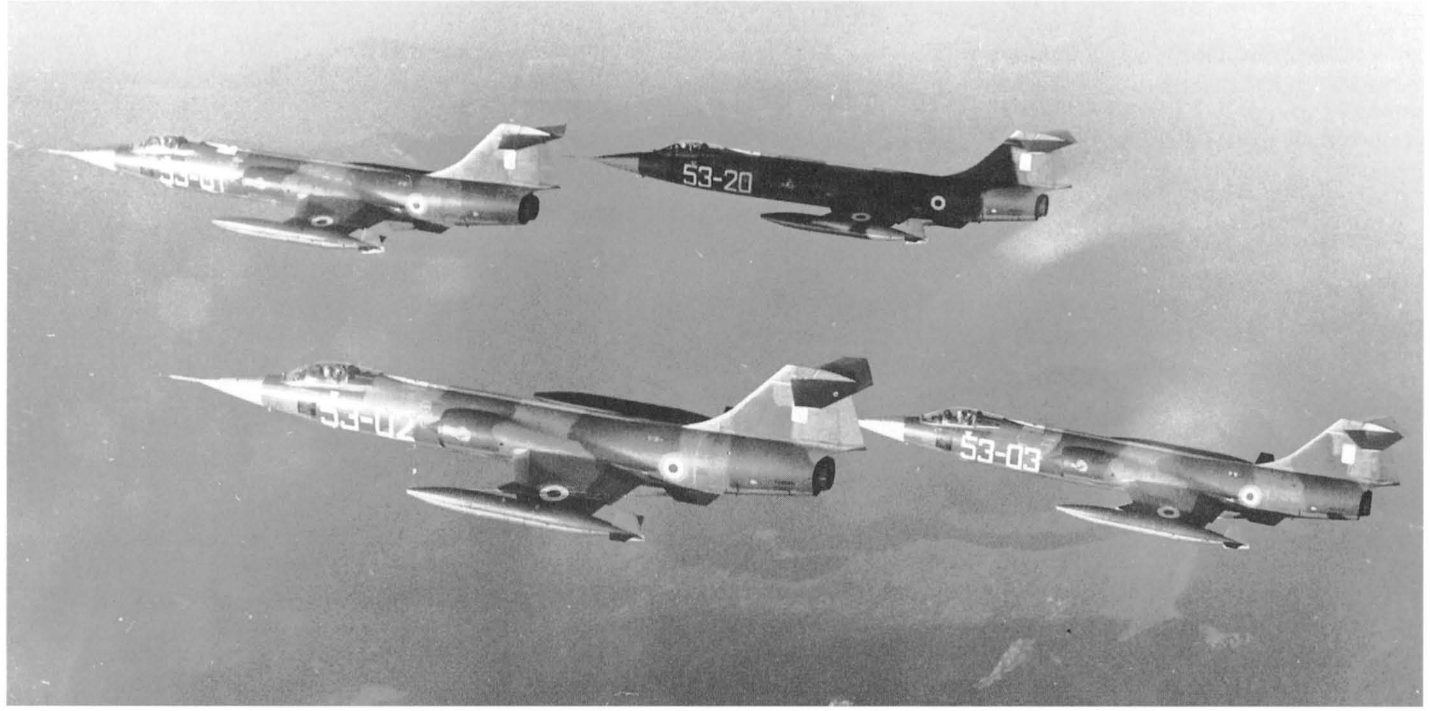


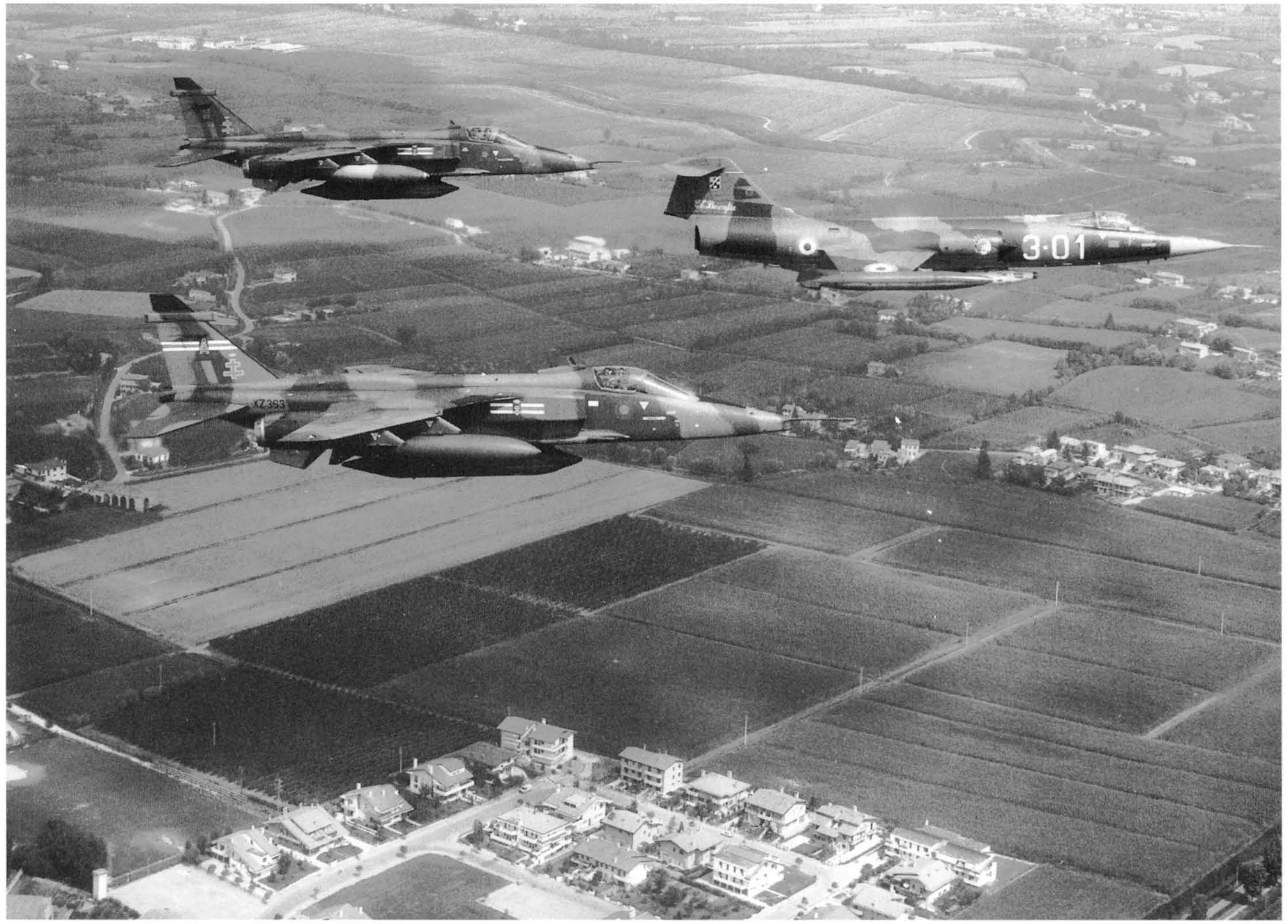
**F-104S 06 of** 53° Stormo 'Gugliemo Chiarini' **of the** Aeronautica Militare Italiana (AMI) **at Novara-Cameri. Note the badge displaying the scimitar on a playing card on the fin.** Air Portraits via *Aeroplane*

*(Below)* **F-104S Starfighters 50-02 of** 50° Stormo **and 52-01 of** 52° Stormo **of the** Aeronautica Militare Italiana (AMI) **in flight.** AMI

*(Bottom)* **F-104S 03, 02, 01 and 20 of** 53° Stormo 'Gugliemo Chiarini' **of the** Aeronautica Militare Italiana (AMI) **in formation.** AMI

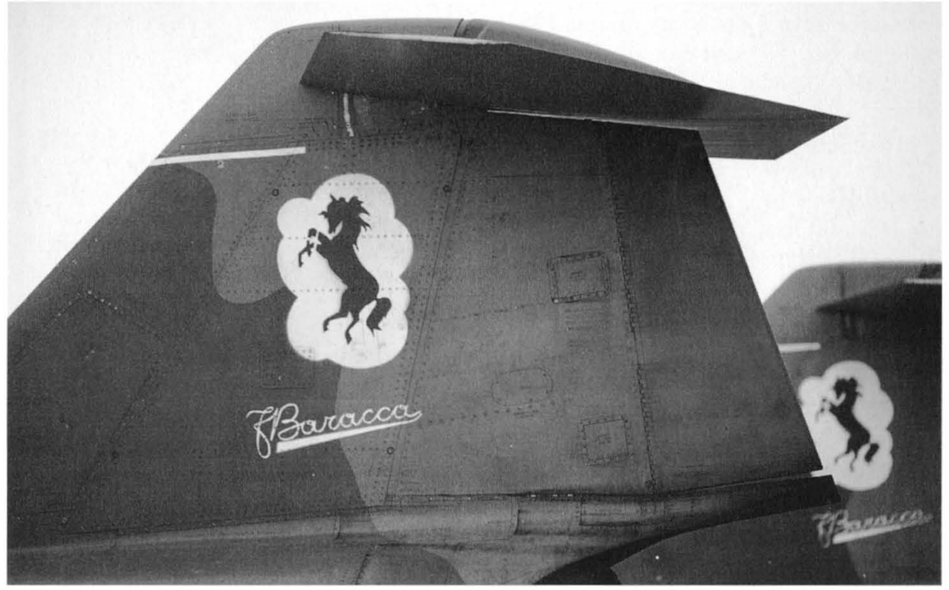






**F-104G 01 of** 3° 'Carlo Emanuele Buscaglia' **of the** Aeronautica Militare Italiana (AMI) **with two Jaguars of No.41 Squadron from RAF Coltishall, Norfolk, flying near Venice.** RAF Coltishall

**All roads may lead to Rome but follow the sign to Treviso–Istrana and the home of** 51° Stormo 'Ferrucio Serafini'. **51° Stormo's badge is a cat trapping three mice.** Matthias Vogelsang



**A pair F-104S Starfighters of** 9° Stormo 'Francesco Baracca', Aeronautica Militare Italiana (AMI)**, with the famous 'black horse rampant', at Colmar in 1992. The unit takes its name from the House of Baracca, named for Francesco Baracca, a cavalry officer who became a pilot.** Matthias Vogelsang

**RF-104G Starfighters 03 and 36 of** 3° Stormo ‘Carlo Emanuele Buscaglia’ **of the** Aeronautica Militare Italiana **(AMI) in flight.** AMI

re-equipment order was cancelled and the reconnaissance unit reverted to the F-86F until replacement by the Fiat G91Y).

In March 1963 the 9° *Gruppo CI*, 4° *Stormo ‘Amendo d’Aosta’* became the first operational unit to receive the F-104G. In June 1963 the F-84F equipped *154° Gruppo* CB at Brescia-Ghedi detached from the 6° *Stormo ‘Alfredo Fusca’* to receive F-104Gs, returning to the wing in September 1967 and temporarily operating some RF-104Gs *154° Gruppo* began conversion to the Panavia Tornado in August 1982). In 1964 the *10° Gruppo CI*, *9° Stormo ‘Francesco Baracca’*; *12° Gruppo CI*, *36° Stormo ‘Helmu Seidl’*, *21° Gruppo CI*, *53° Stormo ‘Gugliemo Chiarini’*; *23° Gruppo* CIO, *51° Stormo ‘Ferrucio Sarafini’* at Rimini-Miramare (on 23 March 1973 *23° Gruppo* CIO moved from *51° Stormo* to *5° Stormo ‘Giuseppe* Cenni’ at the same base); and the *102° Gruppo* CB, *5° Stormo ‘Giuseppe Cenni*’, also at Rimini-Miramare, received F-104Gs.

An OCU (Operational Conversion Unit) was also formed, when on 15 February 1965 the *20° Gruppo* re-formed at *20° Gruppo AO (Addestramento Operativeo/OCU) in the* 3° *Stormo ‘Carlo Emanuele Buscaglia’* at Grosseto. In 1972 the *132° Gruppo CR* of the *3° Stormo ‘Carlo Emanuele Buscaglia’* received F/RF-104G Starfighters, but it had to wait until 1977 before receiving Orpheus reconnaissance pods.

Beginning in February 1970 the *AMI*’s F/RF-104G Starfighters were supplement-

### *Aeronautica Militare Italian* (*AMI*, Italian Air Force)

*3° Stormo ‘Carlo Emanuele Buscaglia’*
Badge: The faces of four cats (2 black, 2 white) upon a divided shield
*28° Gruppo CR* F-104G: 2.70–7.80
Motto: Melius Esse Quam Videri
(‘It’s better to be than to see’)
Badge: ‘Strega’ (Witch)
*132° Gruppo CR*: RF/F-104G; 1972
Motto: Sempre I Soliti (‘Dogsbody’)

*4°Stormo ‘Amendo d’Aosta’*
Badge:A white horse rampant
*9° Gruppo CI/COT*
F-104G: 3.63- F-104S: 2.70–2000+
*20° Gruppo AO/COT*
Motto: Unus Sed Leo
F/TF-104G: 15.2.65–
F-104S: –2000+

*5° Stormo ‘Giuseppe Cenni’*
Badge: The goddess Diana
*23° Gruppo CIO/COT*
F-104G: F-104S: 3.73–2000+
Motto: Come Veltri Ch’uscisser DiCatena
(‘Like Greyhounds on a leash’)
*102° Gruppo CB/COT*
F-104G: 5.64 F-104S: 11.73
Badge: ‘Papero’ (combat duck)
Name: ‘Valzer’ (war cry of 102°)

*6° Stormo ‘Alfredo Fusca’*
Badge: A devil’s head
*154° Gruppo CB*
RF/F-104G: 6.63–1982
*155° Gruppo CB/COT*
F-104G: F-104S:1973–1984
Name: ‘Pantere’ (Panthers)

*8° Stormo ‘Gino Priolo’*
Badge: A winged man hurling a bomb
*101° Gruppo CBR*
F-104G: 12.64 – (re-equipment sub. Cancelled)

*9° Stormo ‘Francesco Baracca’*
Badge: A black horse rampant (from the House of Baracca, named for Francesco Baracca, a cavalry officer who became a pilot)

*10° Gruppo CI/COT*
F-104G: 1964–1972
F-104S: 1972–2000+

*36° Stormo ‘Helmut Seidl’*
Badge: An eagle clutching two flashes of lightning
*12° Gruppo CI/COT*
F-104G: 1964–
F-104S: 12.71–1987?

*37° Stormo ‘Cesare Toschi’*
Badge: I’Asso di Bastoni (Ace of clubs playing card) (not approved)
Motto: Ocio Che Te Cop
(‘Be aware that I will kill you’)
*18° Gruppo Misto/COT*
F-104G: 2.74–1.11.77.
F-104S: –2000+

*51° Stormo ‘Ferrucio Serafini’*
Badge: A cat trapping three mice
*22° Gruppo CIO/COT*
F-104S 1970–1987?
Name ‘Plutos’

*53° Stormo ‘Gugliemo Chiarini’*
Badge: A scimitar on a playing card
*21° Gruppo CI/COT*
F-104G: 4.64– F-104S:
Motto: ‘Ad Hostes Rugens’

### NATO Starfighter Units

***Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu,* Belgian Air Force*)***

1 Wing de Chasse/1 Jachtwing

Motto: Audeo Aciem
(‘I Dare’)

349 Escadrille/Smaldeel
Badge: Two crossed ‘morning stars’

350 Escadrile/Smaldeel
Badge: A gaul’s head

F-104G 1960–1980

10 Wing Chasseurs-Bombardiers/10 Wing Jager-Bommenwerpers
Motto: Fortuna Favet Fortibus
(‘Fortune Favours the Strong’)

23 Escadrille/Smaldeel
Badge: A devil holding two bombs
F-104G: 1964–1983

31 Escadrille/Smaldeel
Motto: In Sanguine Vinum
Badge: A leaping tiger
F-104G 1964–1984

***Kongelide Danske Flyveväbnet* (*KDF*, Royal Danish Air Force)**

723 Eskadrille
Badge: A spread eagle
F-104G 1.65–1 January 1984
CF-104: early 1970s–1 January 1984

726 Eskadrille
Badge: Three falcon claws conjoined
F/TF-104G: 12.64–30 April 1986
CF-104/104D: 8.73–30 April 1986

***Elliniki Aeroporia* (Royal Hellenic (Greek) Air Force)**

116 PtÈrix Mahis
335 Mira D ‘Tiger’
F-104G: April 1964–1976

336 Mira D ‘Olympus’
F-104G: 1964–1976

***Koninklijke Luchtmacht* (*KLu*, Royal Netherlands Air Force)**

306 Squadron
Badge: The head of an eagle
F-104G: 1.1.63–September 1984
RF-104G
TF-104G

311 Squadron
Badge: An eagle in flight
F-104G: June 1964–September 1983

322 Squadron
Badge: A parrot
F-104G: 1 August 1964–April 1979

323 Squadron TACTESS
Badge: The goddess Diana
F-104G: September 1963–August 1980
TF-104G

312 Squadron
Badge: Two swords, crossed
F-104G: June 1964–September 1983

***Kongelige Norske Flyvapen* (*KNL*, Royal Norwegian Air Force)**

*Skvadron 331*
Badge: Two swords, crossed (wears Red/white/blue flash on fin)
F/TF-104G 8.63–summer 1981

*Skvadron 334*
Badge: A red and white fin flash

CF-104/104D: winter 1973/74–1982

***Luftwaffe* & *Marineflieger* (Federal German Republic)**

JaboG31 ‘Böelcke’
Badge: A winged sword

311 and 321 Staffeln
F-104G: Fully operational
20.2.62–30 April 1983

JaboG32
Badge: An eagle clutching a missile
322 and 333 Staffeln
F-104G: 31.12.64–April/July 1984

JaboG38
Badge: Three aircraft
(F-86, F-104, Tornado)
381 Staffel
F-104G: 1960–1983

JG71 ‘Richtofen’
Badge: The letter ‘R’
711 and 712 Staffeln
F-104G: May 1963–March 1974

JaboG33
Badge: A diving eagle within a shield
331 and 332 Staffeln
F-104G: declared operational
by 12.64–30 May 1985

JaboG34
Badge: Two aircraft over mountains
341 and 342 Staffein
F-104G: 1 July 1964–1987

JaboG36
361 and 362 Staffein
Badge: A white horse rampant
F-104G: 20 February 1965–1974

JG41 ‘Mölders’
Badge: An aircraft over a runway
741 and 742 Staffeln
F-104G: 1 July 1964–September 1974

AG51 ‘Immelmann’
Badge: An owl
511 and 512 Staffein
F-104G: November 1963–December 1970

AG52
Badge: A tiger’s head
521 and 522 Staffein
F-104G: October 1964–May 1972

***Marineflieger* (Federal German Republic)**

MFG1
*1 Staffel* *2 Staffel*
Badge: Eagle diving over water
F-104G: 1964–1 July 1982

MFG2
*1 Staffel* *2 Staffel*
Badge: ?
F-104G: 1965–summer 1986

**No. 1 Air Division, Royal Canadian Air Force/CAF**

No.417 Squadron
Cold Lake, Alberta
CF-104/CF-104D: 1963–1970

No.421 ‘Red Indian’ Squadron
No.1 Wing/No.4 Wing
CF-104/CF-104D: 6.11.63–summer 1970
Grostenquin, Fr. 1963–64
Baden Söllingen, Ger. 1964–70

No.422 Squadron
No.4 Wing
CF-104/CF-104D: 1963–summer 1970
Baden Söllingen, Ger. 1963–70

No. 427 ‘Lion’ Squadron
No.3 Wing/No.4 Wing
CF-104/CF-104D: 12.62–summer 1970
Zweibrücken, Ger. 1962–70
Baden-Söllingen, Ger. 1969–70

No.430 Squadron
No.3 Wing/No.4 Wing
CF-104/CF-104D: 1963–summer 1970
Grostenquin, Fr. 1963–64
Zweibrücken, Ger. 1964–69
Lahr, Ger. 1969–70

No.434 Squadron
No.3 Wing
CF-104/CF-104D: 1963–31.3.67
Zweibrücken, Ger. 1963–67

No.439 ‘Tiger’ Squadron
No. 1 Wing/No.3 Wing
CF-104/CF-104D: 1964–1.7.83
Marville, Fr. 1964–67
Lahr, Ger. 1967–70
Baden Söllingen, Ger. 1970–83

No.441 ‘Silver Fox’ Squadron
No.1 Wing/No.3 Wing
CF-104/CF-104D: 1964–1 March 1986
Marville, Fr. 1964–67
Lahr, Ger. 1967–70
Baden-Söllingen, Ger. 1970–86

No.444 Squadron
No.4 Wing
CF-104/CF-104D: 1963–31.3.67
Baden-Söllingen, Ger. 1963–67

ed by the much improved F-104S all-weather interceptor (*caccia ogni tempo*) version. The *AMI* received two Fiat-built F-104Gs modified to F-104S standard by Lockheed (MM6658 and MM6660) and 204 Fiat-built examples (it should have been 205 but MM6766 was destroyed in an accident before delivery). The 9° *Gruppo CI* of the 4° *Stormo 'Amendo d'Aosta'* at Grosseto, was equipped with F-104S models in February 1970, followed by the *22° Gruppo CIO* of the *51° Stormo 'Ferruccio Serafini'* at Treviso-Istrana.

In December 1971 the *12° Gruppo COT* of the *36° Stormo 'Helmut Seidl'* received its F-104S models. The *10° Gruppo COT* of the 9° *Stormo 'Francesco Baracca'* at Grazzanise received F-104S models in 1972. In the 5° *Stormo 'Giuseppe Cenni'* at Rimini-Miramare the *23° Gruppo COT* received the F-104S in March 1973, followed by November onwards, by the *102° Gruppo* CB. By 1973 *the 155° Gruppo* CB of the 6° *Stormo 'Alfredo Fusca'* at Istrana was also operating the F-104S.

**F-104S Starfighters 36, 54 and 42 of** 37° Stormo 'Cesare Toschi' **of the** Aeronautica Militare Italiana (AMI) **in formation.** AMI

**F-104S Starfighter 05 of** 36° Stormo 'Helmut Seidl' **of the** Aeronautica Militare Italiana (AMI) **in flight.** AMI

| **Specification – Fiat F-104S** | |
|---|---|
| Model: | CL-901 |
| Type: | Multi-role, all-weather fighter |
| Crew: | Pilot only |
| First Flight: | (Lockheed-modified F-104S) 30 December 1966 |
| Powerplant: | One 11,870lb (5,385kg) static thrust, 17,900lb (8,120kg) afterburning Italian-built J79-GE-19 turbojet |
| Dimensions: | Span, without tip tanks, 21ft 11in (6.68m); wing area, 196.1sq ft (18.21m$^2$); length, 54ft 8in (16.66m); height, 13ft 6in (4.11m) |
| Empty weight: | 14,900lb (6,760kg) |
| Combat weight: | 21,690lb (9,840kg) |
| Max take-off weight: | 31,000lb (14,060kg) |
| Performance: | Max speed, 1,450mph (2,334km/h) at 36,000ft (10,970m)<br>Cruising speed, 610mph (982km/h)<br>Climb in one minute, 55,000ft (16,760m)<br>Service ceiling, 58,000ft (17,680m)<br>Range, 1,550 miles (2,494km)<br>Maximum range, 1,815 miles (2,921km)<br>Combat radius, 775 miles (1,247km) |
| Fuel: | Standard internal fuel tanks capacity, 896 USgal (3,392l). Provision for two 195 USgal (163 imperial gal/740l) external tanks |
| Armament: | One 20mm M-61 Vulcan rotary cannon, four AIM-7 |
| Options: | Sparrow BVR AAM missiles, 7,500lb (3,400kg) bombs. LAU-3A 2.7in (70mm) FFAR pod containing 19 rockets |

**Starfighters for the *AMI*/Italian Air Force**

| *Serials* | *Type* | *No. Built* |
|---|---|---|
| LOCKHEED | | |
| 63-12685/129696 | TF-104G (MAP) | 12 |
| 583H-5201/5212 | TF-104G (CO-PRO) | 12 |
| FIAT | | |
| MM6502/MM6599 | F-104G | 98 |
| MM6601 | F-104G | 1 |
| MM6603 | F-104G | 1 |
| MM6608/MM6611 | F-104G | 4 |
| MM6631/MM6638 | F-104G | 8 |
| MM6643/MM6651 | F-104G | 9 |
| MM6658/MM6660* | F-104G | 3 |
| FIAT | | |
| MM6701/MM6850# | F-104S | 150 |
| MM6869/MM6883 | F-104S | 15 |
| MM6890 | F-104S | 1 |
| ? | F-104S | 39 |

** MM6658 & MM6660 subsequently modified to F-104S by Lockheed*
*# MM6766 was destroyed in an accident before acceptance*

These were replaced in 1984 as crews began their Tornado conversion courses. Additionally, the *18° Gruppo Misto* (mixed) of the *37° Stormo 'Cesare Toschi'* at Rapani-Birgi, the *20° Gruppo COT* of the *4° Stormo*, and the *21° Gruppo COT* of the *53° Stormo 'Gugliemo Chiarini'* at Novara-Cameri also operated in the F-104S.

In the early 1980s six ex-*Luftwaffe* TF-104Gs were acquired and these joined the AMI inventory in 1988 after they were refurbished by Aeritalia in Turin. In 1986, the *AMI* was the largest operator of Starfighters with eleven *gruppi* of F-104s.

The *28°* and *132°* Gruppi CR *of the 3° Stormo 'Carlo Emanuele Buscaglia'* at Verona-Villafranca had a *Misto* (mix) of F/RF-104Gs (in July 1980 the *28° Gruppo CR* (*Caccia-Ricognizione*/fighter-reconnaissance) was taken off operations and assigned to training. The *12° Gruppo CI* of the *36° Stormo Helmut Seidl* at Gioia de Colle flew F-104Gs, and the *20° Gruppo AO* of the *4° Stormo 'Amendo d'Aosta'* at Grosseto operated TF-104Gs in the conversion training role.

From 1983 to 1993, 147 F-104S Starfighters were modified to F-104S ASA

**TF-104G MM54257/-34 of** 4° Stormo 'Amendo d'Aosta' **of the** Aeronautica Militare Italiana (AMI) **at Kleine Brogel, Belgium, November 1999.** Roger Seroo

***(Below)*** **F-104ASA Starfighters of** 4° Stormo 'Amendo d'Aosta' **of the** Aeronautica Militare Italiana (AMI) **visiting Kleine Brogel, Belgium, in 1999.** Peter Loncke

**F-104ASA MM6739/5-47 of the Rimini-Miramare based** 23° Gruppo C10, 5° Stormo 'Giuseppe Cenni' **of the** Aeronautica Militare Italiana (AMI) **at Cervia-San Giorgio, Italy, in October 1999.** Roger Seroo

(*Aggiornamiento Sistema d'Arma*), or 'updated weapon system' standard. Delivery of F-104S ASA Starfighters began in February 1987 with the first examples being issued to *23° Gruppo CIO* of *5° Stormo 'Giuseppe Cenni'* at Rimini-Miramare. At the beginning of 1995 the *AMI* possessed 125 F-104S ASA Starfighters, distributed among seven *gruppi*: *9° Gruppo CI*, *4° Stormo*, at Grosseto, *23° Gruppo CIO*, *5° Stormo*, at Rimini-Miramare, *10° Gruppo CI*, *9° Stormo*, at Capua-Grazzanise, *12° Gruppo CI*, *36° Stormo*, at Gioa del Colle, *18° Gruppo Misto*, *37° Stormo*, at Trapani-Birgi, *22° Gruppo CIO*, *51° Stormo*, at Reviso-Istrana, and *21° Gruppo CI*, *53° Stormo 'Gugliemo Chiarini'*, at Novarra-Cameri, twenty-five miles east of Milan. By early 2000 the AMI's Starfighter inventory had shrunk to five F-104 units: *10° Gruppo CI* at Caserta, *9° Gruppo CI* and *20° Gruppo AO* at Grosseto, *23° Gruppo CIO* at Ravenna, and *18° Gruppo Misto* at Trapani.

**Specification – Fiat F-104S ASA**

| | |
|---|---|
| Type: | Multi-role, all-weather fighter |
| Crew: | Pilot only |
| First Flight: | December 1984 |
| Powerplant: | One 11,870lb (5,385kg) static thrust, 17,900lb (8,120kg) afterburning Italian-built J79-GE-19 turbojet |
| Dimensions: | Span, without tip tanks, 21ft 11in (6.68m); wing area, 196.1sq ft (18.21m$^2$); length, 54ft 9in (16.69m). Height, 13ft 6in (4.11m) |
| Empty weight: | 14,980lb (6,795kg) |
| Combat weight: | 21,690lb (9,840kg) |
| Max take-off weight: | 31,000lb (14,060kg) |
| Performance: | Max speed, 1,450mph (2,334km/h) at 36,000ft (10,970m)<br>Cruising speed, 610mph (982km/h)<br>Climb in one minute, 55,000ft (16,760m) (279m/sec)<br>Service ceiling, 58,000ft (17,680m)<br>Range, 1,550 miles (2,490km)<br>Maximum range, 1,815 miles (2,920km)<br>Combat radius, with two external tanks, wingtip tanks, and two AAMs, 675n miles (1,250km); ferry range, 1,575n miles (2,915km) |
| Fuel: | Standard internal fuel tanks capacity, 896 USgal (3,392l).<br>Provision for two 195 USgal 740l) external tanks |
| Armament: | One 20mm M-61 Vulcan rotary cannon, four AAM |
| Options: | Missiles (normally two AIM-9L and two Alenia Aspide 1A BVR), 7,500lb (3,400kg) bombs. LAU-3A 2.75in (70mm) FFAR pod containing 19 rockets |

## The Netherlands

Altogether, the *Koninklijke Luchtmacht* (*KLu*, Royal Netherlands Air Force) received 138 Starfighters, comprising eighteen RF-104Gs, 102 F-104Gs (including twenty-five F-104Gs built by Fiat), and eighteen Lockheed/co-produced TF-104Gs. The first Starfighter for the *KLu* to be assembled by Fokker flew on 11 November 1961 at Schiphol Airport, Amsterdam, with company chief test pilot A.P. Moll at the controls. The first Fokker-built Starfighters delivered to the *KLu* (F-104Gs D-8013 and D-8022) were flown to Twenthe Air Base on 12 December 1962 by Kapiteins Okkerman and Janssen. These two Starfighters entered service with No.306 (Reconnaissance) Squadron, which was in the process of replacing its Hunters and F-86K Sabres, and which initially also operated as the OCU for the Starfighter. The *Operationele Conversie Unit* (OCU), also known as the *Dutch Masters* was established on 24 April 1963 and flying commenced using F-104Gs D-8047 and D-8049. A large proportion of the pilots for the OCU were not unsurprisingly drafted in from No.306 Squadron.

**Starfighters entered service with the** Koninklijke Luchtmacht (KLu, **Royal Netherlands Air Force) in December 1962, with No.306 Squadron, at Twenthe. F-104G D-8267 of No.311 Squadron, seen here at the 1966 Tactical Weapons Meet, was lost in a crash at Bremen, Germany, on 20 September 1971.** B. van der Klaauw via *Aeroplane*

***(Below)*** **F-104G D-8341 of No.323 Squadron of the** Koninklijke Luchtmacht (KLu, **Royal Netherlands Air Force). This aircraft was lost at Wildenrath, Germany, on 21 November 1978.** Dutch Defence Dept

In September 1963 No.306 Squadron received its first RF-104G but it was not until July 1964 that this squadron was fully operational on the RF-104G (one TF-104G – D-5811 – was assigned between 1966 and 1969). Its aircraft were then being equipped with Dutch-made cameras from De Oude Delfe. The squadron moved to Volkel on 3 September 1969. Beginning in November 1974, the RF-104G's cameras were being replaced by the Fokker-built Orpheus pod holding five TA-8M cameras and one Infra-Red-Line-Scanner (IRLS) which enable reconnaissance at night. Previously the cameras had to be mounted inside the base of the fuselage.

The F-104Gs were operated in the all-weather interceptor role by No.322 Squadron, and No.323 TACTESS (*Tactisch Training, Evaluatie en Standaardisatie Squadron*) at Leeuwarden, 1964–80.No.322 Squadron had previously flown Hunter Mk6s at Mokmer, Indonesia, from August 1960 to August 1962, when it had disbanded. On 1 August 1964 the Royal Netherlands Air Force's premier fighter squadron re-formed at Leeuwarden with F-104Gs. Meanwhile, on 30 August 1963 No.323 Squadron flew its last Hunter sortie and it too converted to the Starfighter.

In April 1979 No.322 Squadron was partially stood down, and its pilots began training with the locally raised *Conversie Afdeling F-16* from April 1980 onwards. (Conversion of No.322 Squadron's pilots was completed on 1 May 1981 when the unit became the first in the *KLu* to achieve 'limited operational status' on the European-built General Dynamics F-16A/B, becoming 'combat ready' on 1 September). On 16 April 1979, No.323 Squadron absorbed most of No.322 Squadron's pilots and F-104Gs and assumed the semi-official title, 'No.645 Squadron' (arrived at by adding 322 and 323!) In August 1980 No.323 Squadron was stood down for F-16 conversion and it became fully operational on the Fighting Falcon on 1 April 1982.

Starfighters were operated in the fighter-bomber role by Nos.311 and 312 Squadrons at Volkel. In June 1964 No.311 Squadron retired its F-84F Thunderstreaks and took delivery of the F-104G, operating the Starfighter until 1982. No.312 Squadron retired the last of its Thunderstreaks on 1 December 1965 and began operating the F-104G Starfighter, which it continued to fly until No.312 Squadron was stood down for F-16 conversion on 1 June 1984. F-16s began arriving on 16 July and No.312 Squadron passed its F-104s on to the specially formed *Uitfaseringsonderdeel* (Phase-Out Unit), also at Volkel, with which the last Starfighter was withdrawn from service on 21 November 1984.

Two other Starfighter-equipped units, the CAV (*Conversie All-Weather Vlucht*), and the TCA (*Transitie en Conversie* AWX (all-weather), operated F-104Gs and TF-104Gs at Volkel 1968–84, and at Leeuwarden 1968–78, respectively. Altogether, the RNLAF lost 44 Starfighters in crashes or that were written off. Nineteen pilots were killed. On 21 November 1984 the *KLu* flew its Starfighter farewell flight when F-104Gs D-8063 and D-8258 and TF-104Gs D-5803, D-5804 and D-5810, flew formation for the last time in Dutch skies. The last *KLu* Starfighter flight (TF-104G D-5803) touched down at 10.49 hr on 26 November 1984 at Ypenburg.

**Starfighter Totals by Manufacturer**

***Koninklijke Luchtmacht* (*KLu,* Royal Netherlands Air Force)**

| LOCKHEED/CO-PRODUCED | | | | | |
|---|---|---|---|---|---|
| Serial | Type | | | | |
| D-5702 | TF-104G-LO | 1 | | | |
| D-5801/D-5813 | TF-104G-LO | 13 | | | |
| D-5814/D-5817 | TF-104G-LO<br>(co-produced) | 4 | | | |
| Total | | 18 | | | |
| FIAT | | | | | |
| D-6652/D-6657 | F-104G | 6 | | | |
| D-6666/D-6671 | F-104G | 6 | | | |
| D-6680/D-6685 | F-104G | 6 | | | |
| D-6694/D-6700 | F-104G | 7 | | | |
| Total | | 25 | | | |
| FOKKER | | | | | |
| D-8013 | F-104G | 1 | D-8133 | RF-104G | 1 |
| D-8022 | F-104G | 1 | D-8135 | RF-104G | 1 |
| D-8045 | F-104G | 1 | D-8138 | RF-104G | 1 |
| D-8047/D-8054 | F-104G | 8 | D-8141 | RF-104G | 1 |
| D-8057/D-8063 | F-104G | 7 | D-8143 | RF-104G | 1 |
| D-8065/D-8066 | F-104G | 2 | D-8145 | RF-104G | 1 |
| D-8082/D-8084 | F-104G | 3 | D-8147 | RF-104G | 1 |
| D-8089/D-8091 | F-104G | 3 | D-8243/D-8245 | F-104G | 3 |
| D-8093 | F-104G | 1 | D-8256/D-8260 | F-104G | 5 |
| D-8098/D-8099 | F-104G | 2 | D-8266/D-8268 | F-104G | 3 |
| D-8101 | RF-104G | 1 | D-8272/D-8273 | F-104G | 2 |
| D-8103 | RF-104G | 1 | D-8279/D-8283 | F-104G | 5 |
| D-8104/D-8105 | F-104G | 2 | D-8286 | F-104G | 1 |
| D-8107 | RF-104G | 1 | D-8288 | F-104G | 1 |
| D-8109/D-8110 | F-104G | 2 | D-8293/D-8294 | F-104G | 2 |
| D-8112 | RF-104G | 1 | D-8297 | F-104G | 1 |
| D-8114/D-8115 | F-104G | 2 | D-8300 | F-104G | 1 |
| D-8117 | RF-104G | 1 | D-8304 | F-104G | 1 |
| D-8119 | RF-104G | 1 | D-8308 | F-104G | 1 |
| D-8120/D-8121 | F-104G | 2 | D-8311/D-8312 | F-104G | 2 |
| D-8123 | RF-104G | 1 | D-8318/D-8319 | F-104G | 2 |
| D-8125 | RF-104G | 1 | D-8324/D-8326 | F-104G | 3 |
| D-8127 | RF-104G | 1 | D-8331/D-8332 | F-104G | 2 |
| D-8129 | RF-104G | 1 | D-8336/D-8338 | F-104G | 3 |
| D-8131 | RF-104G | 1 | | | |
| Total | | | | | 95 |

**Starfighters Operated by the *Koninklijke Luchtmacht* (*KLu,* Royal Netherlands Air Force)**

| *Serial* | *Type* | *Notes* |
|---|---|---|
| D-5702 | TF-104G-LO | To Turkish Air Force 25.8.80. |
| D-5801 | TF-104G-LO | To Turkish Air Force 8.3.84. |
| D-5802 | TF-104G-LO | Issued to OCU. Cat.5. Crashed Flevopolder, Netherlands, 14.4.67. |
| D-5803 | TF-104G-LO | Issued to CAV. Now displayed at Luchtvaart Museum, Twenthe, Netherlands. |
| D-5804 | TF-104G-LO | Issued to CAV. Now displayed at Bad Oeyenhausen. |
| D-5805 | TF-104G-LO | Issued to CAV. Last flew 2.5.84. At KLu Museum. |
| D5806 | TF-104G-LO | Issued to CAV. Now displayed at Schiphol Aviodrome. |
| D5807 | TF-104G-LO | To Turkish Air Force 30.11.83. Cat.5. Crashed at Izmir, Turkey, 30.11.83. |
| D-5808 | TF-104G-LO | To Turkish Air Force 8.11.84. |
| D5809 | TF-104G-LO | To Turkish Air Force 15.12.80. |
| D-8510 | TF-104G-LO | Issued to CAV. Displayed at Hoofddorp Neverlands Luchtvaart. |
| D-5811 | TF-104G-LO | Issued to CAV. Cat.5. Crashed at Schijndel, Netherlands, 19.12.75. |
| D-5812 | TF-104G-LO | To Turkish Air Force 19.2.82. |
| D-5813 | TF-104G-LO | To Turkish Air Force 15.12.80. |
| D-5814 | TF-104G-LO/Fokker | To Turkish Air Force 23.8.82. |
| D-5815 | TF-104G-LO/Fokker | Issued to TCA. Cat.5. Crashed at Zurich, Netherlands, 12.10.76. |
| D-5816 | TF-104G-LO/Fokker | To Turkish Air Force 25.8.80. |
| D-5817 | TF-104G-LO/Fokker | To Turkish Air Force 30.11.83. |
| D-6652 | F-104G (Fiat) | To Turkish Air Force 19.1.82. |
| D-6653 | F-104G (Fiat) | To Turkish Air Force 19.1.82. |
| D-6654 | F-104G (Fiat) | To Turkish Air Force 19.1.82. |
| D-6655 | F-104G (Fiat) | To Turkish Air Force 15.12.80. |
| D-6656 | F-104G (Fiat) | To Turkish Air Force 19.1.82. |
| D-6657 | F-104G (Fiat) | Issued to 323 Squadron. Cat.5 9.2.78. Crashed at Havelte, Netherlands. |
| D-6666 | F-104G (Fiat) | To Greek Air Force 23.7.82. |
| D-6667 | F-104G (Fiat) | To Turkish Air Force 19.1.82. Displayed at Eskisehir Museum, Turkey. |
| D-6668 | F-104G (Fiat) | To Greek Air Force 23.7.82.. |
| D-6669 | F-104G (Fiat) | Issued to 312 Squadron. Cat.5. Crashed at Kassel, Germany 13.10.72. |
| D-6670 | F-104G (Fiat) | To Greek Air Force 7.5.82. |
| D-6671 | F-104G (Fiat) | Issued to 311 Squadron. Cat.5. Crashed at Isselburg, Germany, 22.9.69. |
| D-6680 | F-104G (Fiat) | To Greek Air Force 23.7.82. |
| D-6681 | F-104G (Fiat) | To Greek Air Force 23.7.82. |
| D-6682 | F-104G (Fiat) | Issued to 312 Squadron. Cat.5. Crashed at Berlikum, France, 19.8.74. |
| D-6683 | F-104G (Fiat) | Issued to 312 Squadron. Cat.5. Crashed at Kleef, Germany, 13.8.79. |
| D-6684 | F-104G (Fiat) | To Greek Air Force 7.5.82 |
| D-6685 | F-104G (Fiat) | Issued to 312 Squadron. Cat.5. Crashed at Erp, Netherlands, 12.10.78. |
| D-6694 | F-104G (Fiat) | Issued to 311 Squadron. Cat.5. Crashed at Soest, Germany, 4.6.74. |
| D-6695 | F-104G (Fiat) | To Greek Air Force 7.5.82. |
| D-6696 | F-104G (Fiat) | Issued to 311 Squadron. Cat.5. Crashed at Bremerhaven, Germany, 13.8.71. |
| D-6697 | F-104G (Fiat) | To Greek Air Force 7.5.82. |
| D-6698 | F-104G (Fiat) | Issued to 312 Squadron. Cat.5. Crashed 5 miles E of Texel, Netherlands, 2.11.76. |
| D-6699 | F-104G (Fiat) | To Greek Air Force 23.7.82. |
| D-6700 | F-104G (Fiat) | To Greek Air Force 23.7.82. |
| D-8013 | RF-104G (Fokker) | One of the first two Fokker-built Starfighters delivered to the *KLu*, and flown to Twenth AB, 12.12.62 to enter service with No.306 Squadron. To Turkish Air Force 8.3.84. |
| D-8022 | F-104G (Fokker) | One of the first two Fokker-built Starfighters delivered to the KLu, and flown to Twenthe Air Base on 12.12.62 to enter service with No.306 Squadron. Now at KLu Museum Soesterberg. |
| D-8045 | F-104G (Fokker) | Issued to 322 Squadron. Cat.5. Crashed at Trondheim, Norway, 17.11.64. |
| D-8047 | F-104G (Fokker) | One of two F-104Gs first issued to the OCU on 24 April 1963 to commence flying. Cat.5. Crashed 4km SW of Vlieland, Netherlands, 1.12.81. |
| D-8048 | F-104G (Fokker) | Issued to UFO, Displayed at Woensdrecht. |
| D-8049 | F-104G (Fokker) | One of two F-104Gs first issued to the OCU on 24 April 1963 to commence flying. To Turkish Air Force 15.12.80. |
| D-8050 | RF-104G (Fokker) | Issued to 306 Squadron. Cat. 5. Crashed at, Losser, Netherlands, 5.9.63. |
| D-8051 | F-104G (Fokker) | Issued to UFO. Displayed at Leeuwarden. |
| D-8052 | RF-104G (Fokker) | To Turkish Air Force 30.11.83. Cat.5. Crashed in Germany, 30.11.83. |
| D-8053 | F-104G (Fokker) | Issued to UFO. Displayed at Nieuw Millingen. |
| D-8054 | F-104G (Fokker) | To Luftwaffe 1963 (JA+237). |
| D-8057 | RF-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Crispiniano, Italy, 20.4.77. |
| D-8058 | F-104G (Fokker) | To Turkish Air Force 25.8.80. |
| D-8059 | RF-104G (Fokker) | To Turkish Air Force 8.3.84. |
| D-8060 | F-104G (Fokker) | To Turkish Air Force 19.1.82. |
| D-8061 | F-104G (Fokker) | Issued to 312 Squadron. Now at *KLu* Museum. |
| D-8062 | F-104G (Fokker) | Issued to UFO. Now at Ypenburg. |
| D-8063 | F-104G (Fokker) | Issued to UFO. Now at Volkel. |
| D-8065 | RF-104G (Fokker) | To Turkish Air Force 8.3.84. |
| D-8066 | RF-104G (Fokker) | To Turkish Air Force 30.11.83. |
| D-8082 | F-104G (Fokker) | To Turkish Air Force 15.12.80. |
| D-8083 | F-104G (Fokker) | To Turkish Air Force 25.8.80. |
| D-8084 | F-104G (Fokker) | Issued to UFO. |
| D-8089 | F-104G (Fokker) | To Turkish Air Force 26.8.80. |
| D-8090 | F-104G (Fokker) | To Turkish Air Force 15.12.80. |
| D-8091 | F-104G (Fokker) | Issued to UFO. Now at Vlissingen. |
| D-8093 | F-104G (Fokker) | To Turkish Air Force 15.12.80. |
| D-8098 | F-104G (Fokker) | Served with 322 & 323 Squadrons. Cat.5. Crashed at Wildenrath, Germany, 21.11.78. |

*(continued overleaf)*

**Starfighters Operated by the *Koninklijke Luchtmacht* (*KLu*, Royal Netherlands Air Force)** *(continued)*

| *Serial* | *Type* | *Notes* |
|---|---|---|
| D-8099 | F-104G (Fokker) | Served with 322 & 323 Squadrons. Cat.5. Crashed at Franeker, Netherlands, 6.2.67. |
| D-8101 | RF-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Steenwijk, Netherlands, 14.7.70. |
| D-8103 | RF-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Deursen, Netherlands, 11.11.83. |
| D-8104 | F-104G (Fokker) | Issued to UFO. Cat.5. Crashed at Gütersloh, Germany, 30.7.84. |
| D-8105 | RF-104G (Fokker) | To Turkish Air Force 30.11.83. |
| D-8107 | RF-104G (Fokker) | To Turkish Air Force 8.3.84. |
| D-8109 | F-104G (Fokker) | To Turkish Air Force 25.8.80. |
| D-8110 | F-104G (Fokker) | To Turkish Air Force 25.8.80. |
| D-8112 | RF-104G (Fokker) | To Turkish Air Force 8.3.84. |
| D-8114 | F-104G (Fokker) | Issued to UFO. Displayed at Delft. |
| D-8115 | F-104G (Fokker) | To Turkish Air Force 25.8.80. |
| D-8117 | RF-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Cuxhaven, Germany, 9.2.70. |
| D-8119 | RF-104G (Fokker) | To Turkish Air Force 30.11.83. |
| D-8120 | F-104G (Fokker) | To Turkish Air Force 15.12.80. |
| D-8121 | F-104G (Fokker) | Issued to 322 Squadron. Cat.5. Crashed at Workum, Netherlands, 25.8.71. |
| D-8123 | RF-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Paderborn, Germany, 18.1.68. |
| D-8125 | RF-104G (Fokker) | To Turkish Air Force 30.11.83. |
| D-8127 | RF-104G (Fokker) | To Turkish Air Force 30.11.83. |
| D8129 | RF-104G (Fokker) | To Turkish Air Force 30.11.83. |
| D-8131 | RF-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Crispiniano, Italy, 20.4.77. |
| D-8133 | RF-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Jever Germany, 1.12.81. |
| D-8135 | RF-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Hoogwoud, Netherlands, following mid-air with D-8147, 12.7.65. |
| D-8138 | RF-104G (Fokker) | To Turkish Air Force 8.3.84. |
| D-8141 | RF-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Mariaheide, Netherlands, 20.3.75. |
| D-8143 | F-104G (Fokker) | To Turkish Air Force 30.11.83. |
| D-8145 | F-104G (Fokker) | To Turkish Air Force 30.11.83. |
| D-8147 | F-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Hoogwoud, Netherlands, following mid-air with D-8135, 20.3.75. |
| D-8243 | F-104G (Fokker) | Issued to 312 Squadron. Cat.5. W/O after ground-fire 25.6.73. |
| D-8244 | F-104G (Fokker) | Issued to 312 Squadron. To LETS 21.11.83. |
| D-8245 | F-104G (Fokker) | Issued to UFO. At KLu Soesterberg. |
| D-8256 | F-104G (Fokker) | Issued to 312 Squadron. Now at Volkel. |
| D-8257 | F-104G (Fokker) | Issued to 312 Squadron. Now in pieces at Luchtmacht Museum Soesterberg. |
| D-8258 | F-104G (Fokker) | Issued to UFO. |
| D-8259 | F-104G (Fokker) | Issued to UFO. Now at Hoofddorp Nederlands Luchtvaart College. |
| D-8260 | RF-104G (Fokker) | Issued to 306 Squadron. Cat.5. Crashed at Cösfeld, Germany, 12.8.76. |
| D-8266 | F-104G (Fokker) | Issued to UFO. Now at Luchtvaart Museum, Texel. |
| D-8267 | F-104G (Fokker) | Issued to 311 Squadron. Cat.5. Crashed at Bremen, Germany, 20.9.71. |
| D-8268 | F-104G (Fokker) | Issued to UFO. Now at MTS Zwolle. |
| D-8272 | F-104G (Fokker) | To Turkish Air Force 25.8.80. |
| D-8273 | RF-104G (Fokker) | To Turkish Air Force 8.3.84. |
| D-8279 | F-104G (Fokker) | Issued to 312 Squadron. Gate Guardian at Volkel. |
| D-8280 | F-104G (Fokker) | Issued to 312 Squadron. Cat.5. Crashed at Bremen, Germany, 1.3.79. |
| D-8281 | F-104G (Fokker) | Issued to UFO. Instructional airframe at Fire School LETS. |
| D-8282 | F-104G (Fokker) | Issued to UFO. At Budel Luftwaffe Ausbildungsregiment. |
| D-8283 | F-104G (Fokker) | Issued to 312 Squadron. Cat.5. Crashed at Achel, Beglium, 17.12.74. |
| D-8286 | F-104G (Fokker) | To Turkish Air Force 15.12.80. |
| D-8288 | F-104G (Fokker) | To Turkish Air Force 15.12.80. |
| D-8293 | RF-104G (Fokker) | To Turkish Air Force 30.11.83. |
| D-8294 | F-104G (Fokker) | Served with 322/323 Squadrons. Cat.5. Crashed in North Sea, 3.5.77. |
| D-8297 | F-104G (Fokker) | Served with 322/323 Squadrons. Cat.5. Crashed 80km N of Den Helder, 14.16.79. |
| D-8300 | F-104G (Fokker) | Issued to UFO. Now at Ulthulzen (Martha Roling). |
| D-8304 | F-104G (Fokker) | To Turkish Air Force 28.8.80. |
| D-8308 | F-104G (Fokker) | Issued to 312 Squadron. Cat.5. Crashed at Elsendorp, Netherlands, 9.11.81. |
| D-8311 | RF-104G (Fokker) | To Turkish Air Force 30.11.83. |
| D-8312 | F-104G (Fokker) | Issued to UFO. Now at Volkel. |
| D-8318 | F-104G (Fokker) | Issued to 312 Squadron. At KLu Museum. |
| D-8319 | F-104G (Fokker) | To Turkish Air Force 25.8.80. |
| D-8324 | F-104G (Fokker) | To Turkish Air Force 15.12.80. |
| D-8325 | F-104G (Fokker) | Issued to 322 Squadron. Cat.5. Crashed at Adorp, 23.3.72. |
| D-8326 | F-104G (Fokker) | Issued to UFO. In pieces at Ypenburg. |
| D-8331 | F-104G (Fokker) | Issued to UFO. Now displayed at Tinker AFB air park, OK, USA. |
| D-8332 | F-104G (Fokker) | Issued to 312 Squadron. Cat.5. Crashed at Afferden, 18.1.73. |
| D-8336 | F-104G (Fokker) | Issued to 323 Squadron. Cat.5. Crashed in North Sea 12.3.75. |
| D-8337 | F-104G (Fokker) | Issued to 312 Squadron. Cat.5. Crashed at Newcastle, England, 12.4.83. |
| D-8338 | F-104G (Fokker) | Issued to 312 Squadron. Now at Twenthe AB. |
| D-8341 | F-104G (Fokker) | Issued to 322 Squadron. Cat.5. Crashed at Wildenrath, Germany, 21.11.78. |
| D-8342 | F-104G (Fokker) | To Turkish Air Force 25.5.80. |
| D-8343 | F-104G (Fokker) | Issued to 312 Squadron. Cat.5. Crashed N of Texel 24.1.78. |

**F-104G D-8145 of No.306 Squadron of the** Koninklijke Luchtmacht (KLu, **Royal Netherlands Air Force). This aircraft was acquired by the Turkish Air Force on 30 November 1983.** Dutch Defence Dept

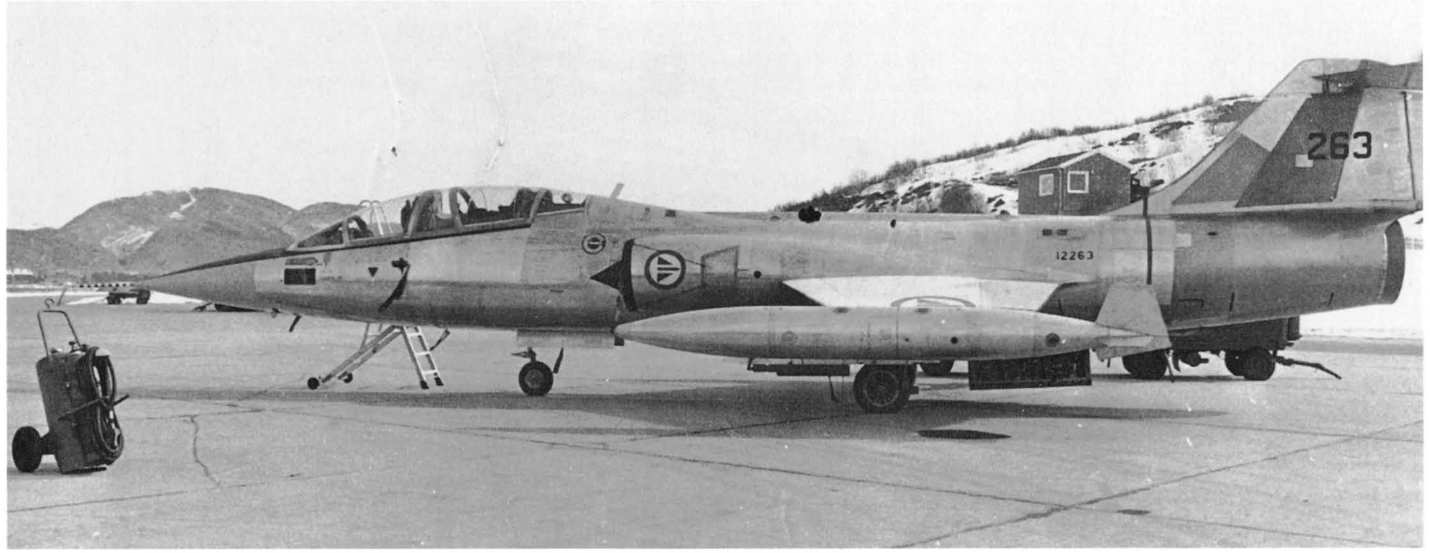
**F-104G D-8115 of No.322 Squadron of the** Koninklijke Luchtmacht **pictured in June 1965. This aircraft was acquired by the** Türk Hava Kuvvetleri (THK, **Turkish Air Force**) **on 25 August 1980. The last of the** KLu's **Starfighters were replaced by European-built General Dynamics F-16A/Bs in November 1984.** Dutch Defence Dept

## Norway

The *Kongelige Norske Luftforsvaret* (*KNL*, Royal Norwegian Air Force) was to receive two *skvadrons* (squadrons) of F-104s, but originally it took delivery of only enough Starfighters for one. (The remaining funds went instead to pay for the purchase of Northrop F-5A/B aircraft to enable Norway to obtain a larger number of aircraft – the second *skvadron* of F-104Gs earmarked for the *KNL* subsequently went to the Royal Hellenic Air Force). The *KNL* received sixteen Canadair-built F-104Gs in 1963 as part of the American MAP programme.

In 1965, the *KNL* bought two RF-104s which were rebuilt to F-104G standard, and in February 1966, one more single-seater, originally a F-104G model. All of the F-104Gs were modified to RF-104G standard for the all-weather fighter/interceptor (AWX) role with *Skv331* at Bødo. The first test flight was in August 1963 and *Skv331* became fully operational in 1967. However, following delivery of the RF-5As for *Skv717*, the Starfighters reverted to the fighter configuration and served in the interception role until 1981 when crew training on the F-16 began. *Skv331*'s surplus F-104Gs were despatched to Turkey in June and July 1981.

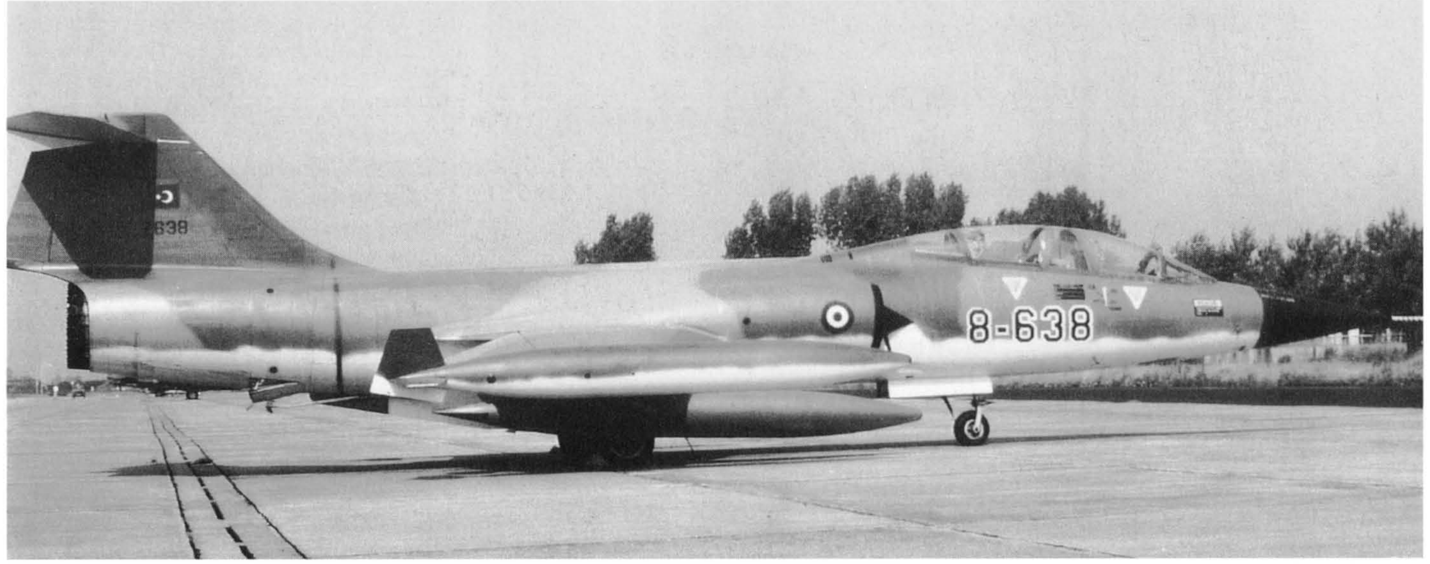
The *KNL* had lost its first Starfighter in 1970 (a two-seater) and as replacement, bought two ex-*Luftwaffe* TF-104Gs in 1975. It was high attrition in the Northrop F/RF-5 inventory however, that led to the disbandment in 1973 of *Skv334*, which then became the second Starfighter unit in the *KNL*. During winter 1973/74 *Skv334* re-formed on the Starfighter at Bødo (later to be based at Rygge) with eighteen ex-Canadian Armed Forces'



***(Above)*** **TF-104G-LO 61-12263 (ex-**Luftwaffe **two-seat trainer) of** Skvadron 331 **of the** Kongelige Norske Luftforsvaret **(**KNL, **Royal Norwegian Air Force). The** KNL **lost its first Starfighter in 1970 (a two-seater) and as replacement, bought two ex-**Luftwaffe **TF-104Gs, one of which was 61-12263, in 1975.** Norwegian Defence Dept

**F-104G of the** Kongelige Norske Luftforsvaret (KNL, **Royal Norwegian Air Force).** Norwegian Defence Dept

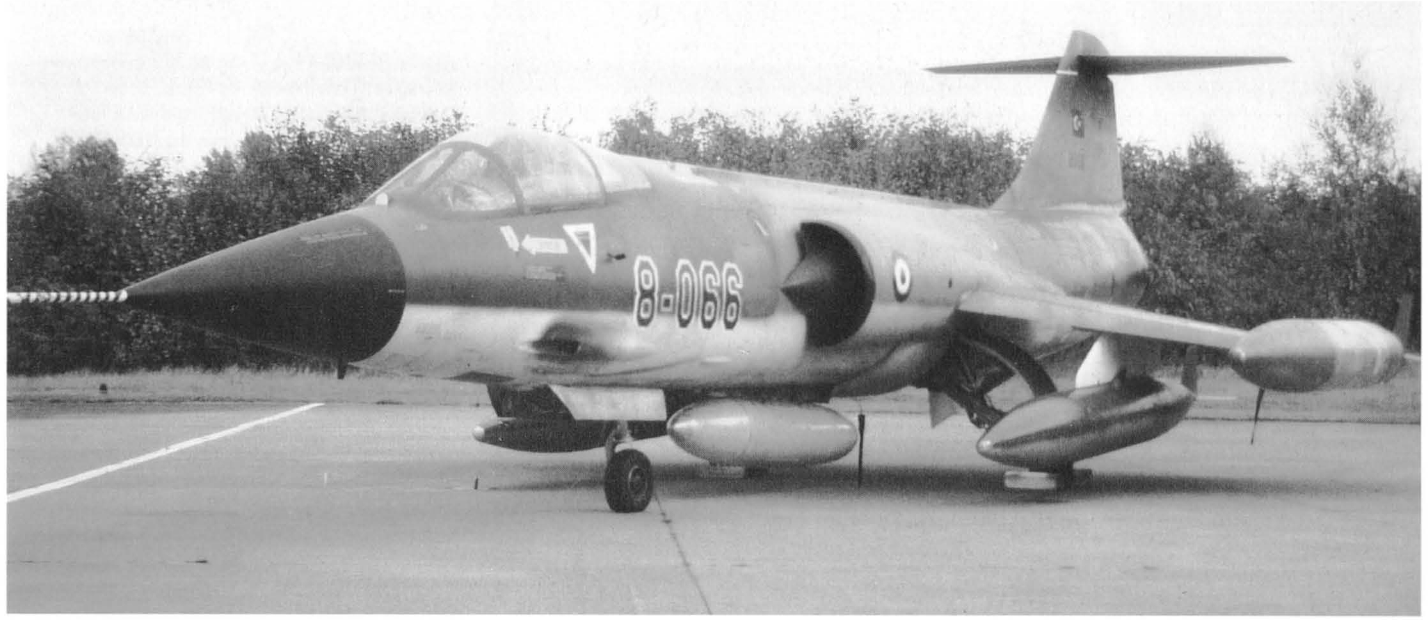
***(Below)*** **TF-104G 8-638 of the 8th Wing,** Türk Hava Kuvvetleri (THK, **Turkish Air Force), one of ten two-seater Starfighters Turkey received from the Netherlands.** Ton van der Zeeuw



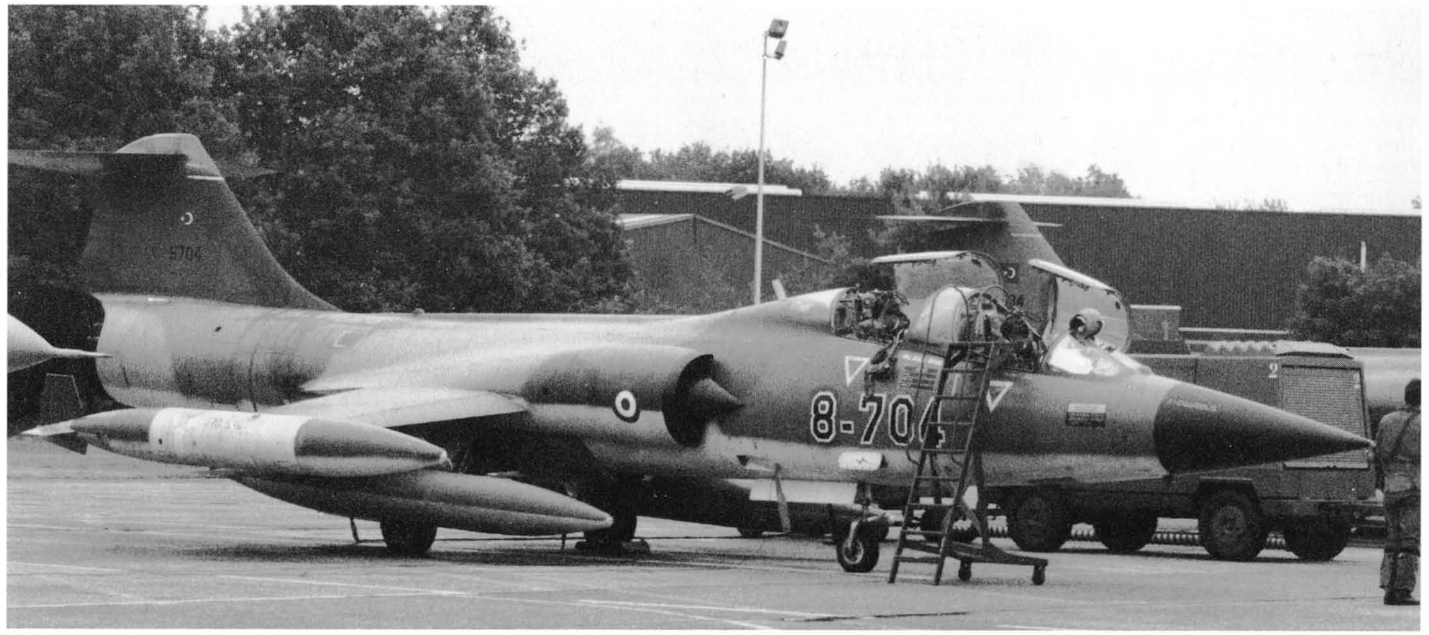
CF-104s, and four CF-104Ds which were built by Canadair from June 1962 to November 1963. These aircraft were modified to carry Martin AGM-12C Bullpup air-to-surface missiles and operate in the anti-shipping role but *Skv334* operated in this role for just one year. The CF-104/CF-104Ds of *Skv334* were finally phased out during the winter of 1982–83 with replacement by F-16A/B aircraft.

## Turkey

In 1965–66 The *Türk Hava Kuvvetleri* (*THK*, Turkish Air Force) received thirty-six new Starfighters (thirty-two single-seaters built by Lockheed and Canadair, and four TF-104Gs) under MAP to equip two *Filos* (squadrons) at the 4th *Ana Jet Us Komutanligi* (Main Jet Base Command) at Mürted and later the 9th *Ana Jet Us Komutanligia* at Balikesir. In 1972 eight F-104Gs and two RF-104Gs were transferred to Turkey from the *Ejercito del Aire* (Spanish Air Force). Subsequently, the *THK* obtained from Italy twenty F-104Gs and, between December 1974 and mid-1976, forty F-104S interceptors, in batches of eighteen and twenty-two. At Mürted, the F-104S models replaced the last of the F-102A Delta Daggers in the fighter interceptor role



**F-104G 8-066 (ex-**KLu **RF-104G D-8066) of the 8th Wing,** Türk Hava Kuvvetleri (THK), **pictured on 30 November 1983. 8-066 was one of eighteen ex-RF-104G models acquired by the Turkish Air Force from the Netherlands (the photo-recce pods however, were not included).** Ton van der Zeeuw



**TF-104G 8-704 (5704) of the 8th Wing,** Türk Hava Kuvvetleri (THK, **Turkish Air Force).** Peter Loncke

**F-104G 8-334 of the 8th Wing,** Türk Hava Kuvvetleri (THK, **Turkish Air Force), based at Mürted. In addition to the ten ex-**KLu **TF-104Gs, and eighteen RF-104Gs, Turkey received twenty-five F-104Gs from the Netherlands.** Peter Loncke

*(Below)* **F-104G 9-056 of the 9th Wing,** Türk Hava Kuvvetleri (THK, **Turkish Air Force), based at Balikesir. Altogether, Turkey received a total of fifty-three Starfighters from the Netherlands.** Ton van der Zeeuw

and came under the command of 8 Wing, being operated by 182 *Filo*. At Balikesir in 1976, the F-104S entered service with 192 *Filo*. In 1976 Turkish Starfighters took part in the invasion of Cyprus.

Turkey signed an agreement late in 1980 with the Netherlands under which the *Türk Hava Kuvvetleri* was to receive forty ex-*KLu* RF/F-104s. A token price of $75,000 for each aircraft was agreed between the two countries. Ultimately, the *THK* acquired a total of fifty-three Starfighters from the Netherlands, twenty-five F-104Gs, eighteen RF-104Gs (the photo-recce pods, however, were not included), and ten TF-104Gs) during 1980–84.

In 1980–81 F-104/TF-104Gs being phased out in Belgium, and Germany, also began to arrive in Turkey. Seventeen F-104Gs came from Belgium during 1981–83, twelve F-104Gs and one TF-104G from Norway in 1981, and about 120 F-104Gs and twenty-eight TF-104Gs from Germany during 1983–89. In 1965 the Canadian government donated forty-four CF-104s and six CF-104Ds (all of which had equipped its 1st Canadian Air Division in Germany) to Turkey. After some minor modifications, these aircraft entered operational service with *181nci Filo* and *182nci Filo, Inci Taktik Hava Kuvvetleri Kumutanligi* (1st Tactical Air Force Command) at Diyarbakir, where they replaced the *THK*'s obsolete F-100s in the close air support role.

By 1986, the varied collection of Turkish Starfighters equipped five *Filos* of the *Inci Taktik Hava Kuvvetleri Komutanligi*; the *141nci* and *142nci Filoler* at Mürted, the *182nci Filo*, and the *191nci* and *192nci* at Balikesir. At Bandirma, the 6th *Ana Jet Us Komutanligi* operated two *filos* of F-104s (*161 Filo*, in the close support role, and *162 Filo*, in the air defence role). By 1993 only the 8th *Ana Jet Us Komutanligi 181nci* and *182nci Filo* and 9th *Ana Jet Us Komutanligi 191st Filo* (F-104S – interdiction role), *192nd Filo* (F-104G – air defence mission) and *193rd Filo* (F/TF-104G – this unit was the OCU for all *THK* F-104 pilots), at Diyarbakir and Balikesir respectively, were still operating the Starfighter. All remaining Starfighters were replaced by the General Dynamics F-16 Fighting Falcon in 1993–94.

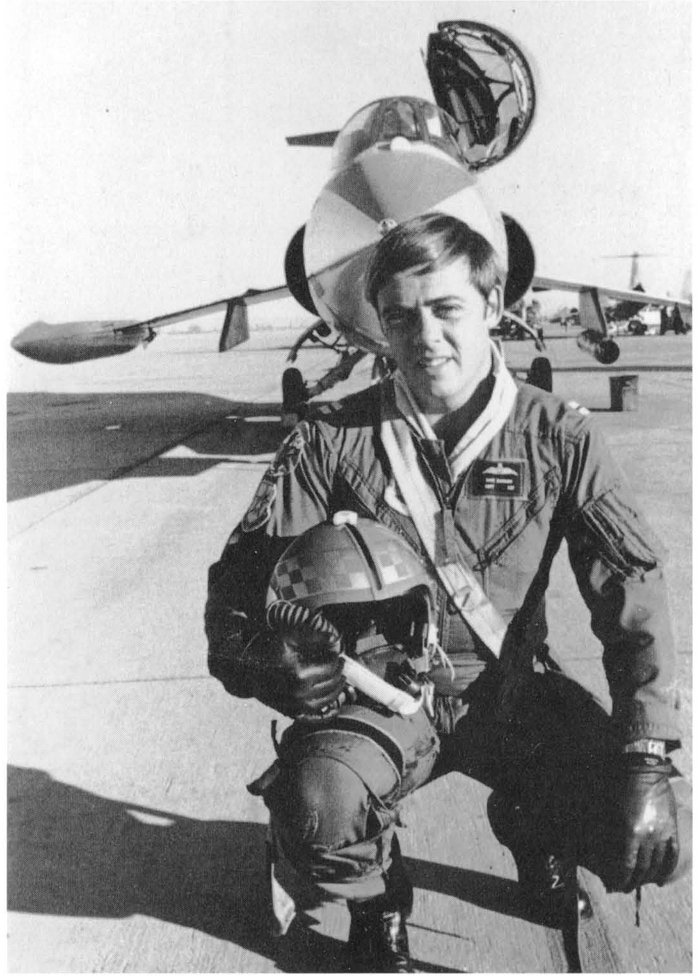
CHAPTER SIX

# Star Warrior

## Lt Col David L. Bashow

*'You love a lot of things if you live around them, but there isn't any woman and there isn't an horse, not any before, nor any after, that is as lovely as an airplane. And men who love them are faithful to them even though they leave them for others. A man has only one virginity to lose in fighters and if it is a lovely plane he loses to, there his heart will ever be.'*

Ernest Hemingway



**Lt Col David L. Bashow.** David Bashow

Everyone has to have a great and timeless love in their life. I shamelessly admit to having two, and they live in complete harmony with each other. The first is my wonderful wife of thirty years. The other is merely the most beautiful aircraft to ever grace the skies, the Lockheed F-104 Starfighter.

The durable love affair started in the early 1960s, when I first saw this striking machine with its pencil-thin fuselage and tiny canard-like wings, was consummated in 1972 when I first flew the jet, and endures to this day, nearly 2,400 flight hours later.

Many aircraft have been christened with nicknames over the years by those who work with them, and the F-104 is no exception. The Americans and Germans like to call it the 'Zipper' or the 'Zip'. We would occasionally refer to it in jest as 'the aluminium death tube', or 'the Flying Phallus', but more often than not, we would just call it 'the 104' or by its given name, 'the Starfighter'. Somehow it seemed so appropriate – an elegant name for an elegant aircraft. One just couldn't conjure up a derisive name from those who flew her. Other airplanes got 'Thud', 'Hog', and 'Aardvark', not so the 104. I *never* heard anyone in the pilot community call it 'the missile with the man in it'. That was pure press hype, and Lockheed had an excellent sales promotion and PR department. Perhaps more to the point, I *never* heard a pilot call it 'the widow maker', and I don't know a self-respecting 104 pilot who would. This is because none of us who flew her blamed her for the relatively high accident rate incurred during 104 operations, especially during the early transition days. I will have more to say on this topic later, but for the most part, the demanding role of the 104 in NATO was the main reason for the elevated accident rate, not the aircraft itself.

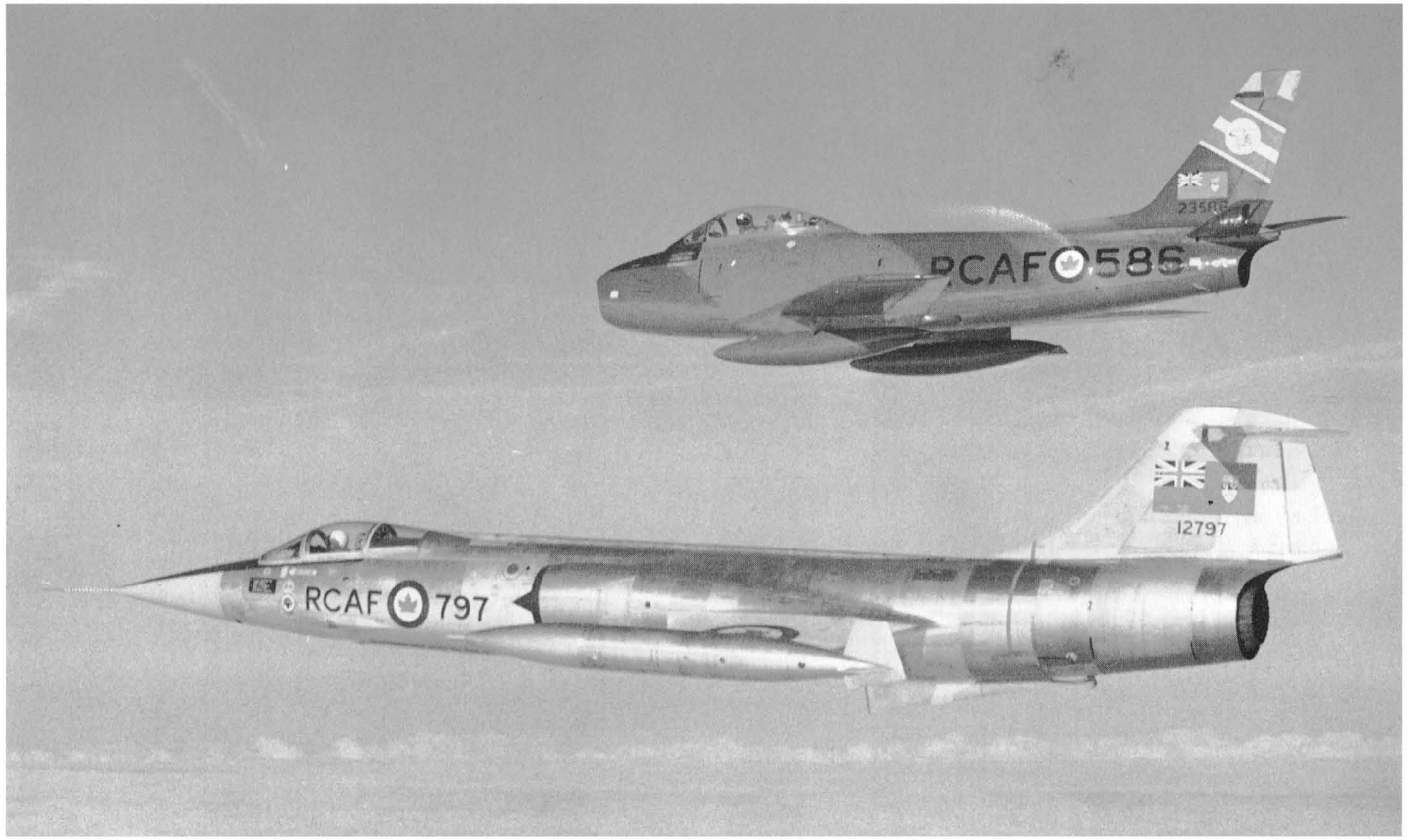
### Noise

Noise was a part of the unique personality of the 104. It made distinctive sounds that manifested themselves on engine run-up and on the overhead break. On run-up, the 15,000lb [6,804kg] thrust General Electric J79 engine made an unearthly shriek that was dubbed 'the moose call' because it sounded exactly like a moose in rutting season and became cause for nervous banter during the moose breeding season in northern Alberta where we were based. The very thought of one of those beasts charging our jets on the button of the runway conjured up an unpleasant image. Perhaps even more distinctive was the unique, supernatural moaning sound, like the wail of a wounded banshee, made by the 104 in the overhead break for landing. Sometimes, it's a pity to let science get in the way of romanticism. Unfortunately, both the moose call on engine run-up and the moaning in the overhead break had technical explanations. The 'moose' was due to a rapid repositioning of the engine inlet guide vanes and the 'moaning' I am told was due to disturbed airflow over the engine air bypass flaps. But to those of us who flew her and lived around her, this was just more 104 magic.

## Flying the F-104

Takeoff was child's play. You engaged nosewheel steering and plugged in the afterburner, which gave a smooth, positive light in seven stages. The stick was just held in the neutral position until approximately 20–25 knots below the computed takeoff speed when back pressure was applied. From then on, flight was (usually) inevitable. Throttle response was truly awesome. Unlike some other jet aircraft, fuel control units metered JP-4 to engine and afterburner such that you never had to worry about over-temping the engine, the net result being that you could bang the throttle around as much as you wanted. A real stop–go lever. Also, unlike today's high bypass engines, spool-up time was very rapid; the resulting thrust changes instantaneous. The power was thus always there when you needed it, and this was a tremendous advantage when flying close formation, and also for making rapid corrections to airspeed in any phase of flight where this was required, such as in the landing pattern or when dropping bombs, where speed accuracy is vital. Often, today's bypass engines produce significant delays from throttle movement to engine response, a condition that requires some forethought to compensate for on the part of the pilot. This was certainly not a problem with the 104.

I personally had the relatively unique experience of flying the jet in both temperature extremes, starting with three years as an instructor (after a long tour in Germany) in Cold Lake, Canada, where we had square tyres and –40°F weather for weeks on end in winter. We used to joke that we had eleven months of winter and one month of bad skiing, but it wasn't far from the truth. The good news was the remarkable effect the cold air had on jet engines. One of the parallel runways at Cold Lake is 12,000ft long, and I can remember that on afterburner takeoff on a –40°F day in a 'clean' (no external stores) aircraft, you could have 450kt on the clock by the end of the runway. The most difficult part was getting the landing gear locked up by its limiting speed of 260kt after takeoff. If you hesitated even a second after nosewheel rotation, you were going to get an overspeed.



**RCAF CF-104 12797 in formation with Canadair Sabre Mk.6 23586 of No.412 'Falcon' Squadron. Canadair CF-104s were fitted with Canadian equipment, were powered by a Canadian-built J79-OEL-7 turbojet, and retained provision for the removable refuelling probe as fitted to the USAF F-104Cs and -Ds.** *Aeroplane*

**CF-104 12781 of the RCAF.** via Philip Jarrett

**CF-104 12703 of the RCAF taking off.** via Philip Jarrett

In marked contrast to this experience were memories of operations in the Arizona desert as an exchange instructor at the USAF/GAF Fighter Weapons School. Over the years, I suppose I've flown just about every configuration the 104 has to offer, but as an antithesis to the clean jet in the wintertime Cold Lake, the dart-tow ship in summertime Phoenix springs to mind. This consisted of two wingtip tanks, a wing pylon tank and the dart rig itself, a cumbersome target device that looked like a huge foil paper airplane that was reeled out in flight under the left wing. On a 140°F runway temperature day, the takeoff roll was spectacular and guaranteed to make a devout Christian out of even the most practised atheist. You can joke about your 'gravel sniffers in the nose' to sense nosewheel rotation time; this situation really called for it. I'll never forget that tyre fail speed was 239kt and at that temperature and configuration, takeoff speed was around 235. The jet ended up clawing her way into the air, waging a personal war with Sir Isaac Newton for every inch of

**RCAF CF-104 Starfighters 12869, 12751, 12800 and 12821, at the 1967 Weapons Meet at RAF Wildenrath, Germany.** via Philip Jarrett

***(Above)*** **CF-104 12765 of the RCAF with Vinten Vicon photo-reconnaissance pod with four 70mm cameras on the centreline.** via Philip Jarrett

altitude gained. It was always a near thing and happiness was staggering away into the heavy summer desert air with the gear safely tucked up and the runway behind you. All this for the privilege of letting someone shoot at you.

Landing was always an impressive, though usually straightforward event. The approach speeds were fast by anybody's standards, but you got used to the speed just like anything else. Normal landing configuration was with LAND (full) flap selected, and a long, flat final approach was flown at 175–180kt with touchdown at 155–160 minimum. To these basic speeds were added extra knots for any fuel over 1,000lb, crosswinds, gusty winds, external stores, mother, wife, kids and so on. In short, it was not at all unusual to add 20kt to the basic speeds. Boundary Layer Control (BLC) was added to the razor wings to lower landing approach and touchdown speeds with LAND flap selected. Because the BLC was only effective down to about 82 per cent engine rpm, the aircraft was unusual in that it was routinely landed with power on. When instructing, we threatened dire consequences to the novice who pulled the power to idle prior to touchdown, since this would result in an abrupt loss of both BLC and lift, usually on one wing before the other, and at best, a bone-jarring arrival on the runway. In reality, as long as the pilot smoothly and slowly reduced power to idle, there was no controllability problem.

**CF-104 12881, 12820 and 12885 of the RCAF at Baden-Söllingen, Germany.** Andy Graham via Steven M. Fochuk

Landing patterns could also be flown with TAKEOFF (half) flap configuration at slightly higher approach speeds than LAND flap, but BLC roll-off was not a factor to worry about. A flapless landing, however, was both an emergency and a memorable experience, especially at night. Final approach/touchdown minimum speeds were 230/195kt respectively, plus additives. You flew a long flat final where you were going like a scalded cat and felt like you were continuously on the ragged edge of disaster. Descent rate was around 800ft per minute and we tended to fly final on a combination of both airspeed and angle-of-attack (AOA) indications. I remember very distinctly a caution Pilot's Notes that sternly warned at no time to allow the rate of descent on a flapless approach to exceed more than 2,000ft per minute as recovery would require more than 400ft of altitude.

In *all* cases, the aircraft was landed with crab on, and you just kicked it straight with nosewheel steering on the post-landing roll. As you can well imagine, increased stopping power was highly desirable and provision was made for this with a big 16t diameter drag chute and an excellent anti-skid braking system. If these didn't work, or we had a takeoff emergency or a slippery runway, we had an arrester hook mounted under the aft fuselage that snagged a cable at the end of the runway. And if *that* didn't work, well then it really wasn't your day. We almost never attempted aerodynamic braking. After all, how efficiently can you aerodynamically brake a pencil?

Stalls and spins were another flight area approached with great caution. Due to the aerodynamics of the high 'T' tail, the aircraft was prone to a phenomenon known as pitch-up at high AOAs. Beyond a certain point, this pitch-up was uncontrollable and resulted in severe gyration (or even structural failure) of the aircraft and a large loss in altitude before recovery to level flight. It was possible to develop stall angles of attack very readily and rapidly during abrupt manoeuvres, even though relatively small amounts of stabilizer were used. In supersonic flight, the usual stall warnings were inadequate to prevent excessive AOA and an Automatic Pitch Control (APC) was therefore provided which initiated corrective action at the proper time to prevent reaching an AOA high enough to cause pitch-up under any operating condition. These warnings took the form of a stick shaker and a kicker, which abruptly kicked the stick forward. It was, in effect, both a built-in buffet warning and an artificial stall that occurred ahead of the aerodynamic stall. Stalls were never practised to completion; recovery action was initiated at either shaker or kicker action, depending on configuration, and stalls were *never* practised below 25,000ft AGL.

***(Above)*** **CAF CF-104 12850.** Andy Graham via Steven M. Fochuk

**CAF CF-104s 12891 and 12845 of the RCAF taking off.** D.G. Hood via *Aeroplane*

Spins were violent, gut-wrenching manoeuvres and intentional spinning was prohibited. A friend of mine had a wild ride one day when one of the main landing gear doors accidentally deployed in supersonic flight during air combat practice. Although he executed a brilliant recovery, the thrill factor was so high that it was several minutes before he was capable of coherent speech.

Because of the jet's rather awesome out-of-control characteristics, pilots generally developed a phobia about flying slow in it at all. At the Weapons School, I would routinely demonstrate a confidence zoom to zero airspeed. Actually, it was perfectly safe under pre-ordained conditions of centre of gravity and fuel weight. The trick was to recover very *gently*, using a very conservative maximum reading on the APC gauge, and rolling the aircraft towards the nearest horizon. Ailerons were very effective well past the stall. In reality, if the pilot were just to take his hands *off* the controls in the vertical stall condition, the aircraft generally knew what it wanted to do better than the pilot did, and would usually recover to a recognizable flight attitude from which a full recovery could be easily made. This would *not* want to be done low to the ground though. Altitude losses in out-of-control situations in the 104 were formidable. For example, ejection was a checklist procedure if recovery was not effected by 15,000ft AGL.

**CF-104 12870 of the RCAF passing a German Schloss.** Andy Graham via Steven M. Fochuk

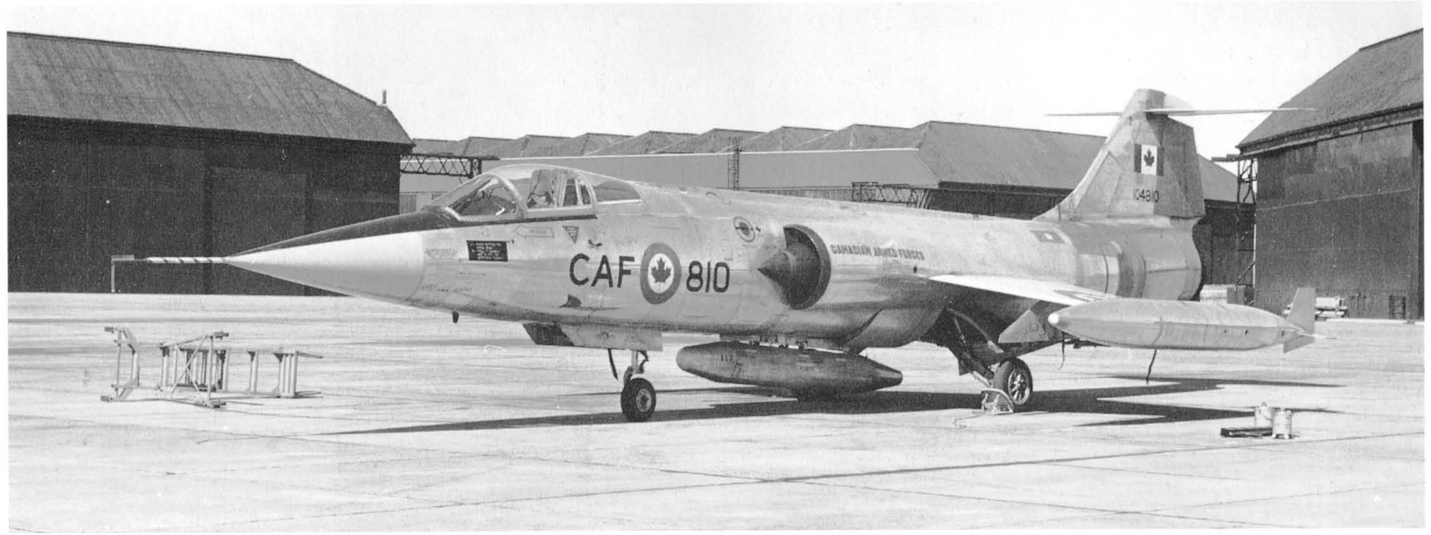
## Quirks and Foibles

The 104 was a relatively sophisticated aircraft in its heyday and possesses relatively advanced components and systems. As pilots, we used to marvel at the seemingly incongruous effect activation of a given button or knob would have on a supposedly unrelated system in the aircraft. Examples of this are legion, but one that comes to mind was running up engine power from idle to retract a stuck windshield rain remover! There were so many of these quirks and foibles that 104 students became just a little gullible to say the least, and from this situation was born the legendary 'Order of the Thruster Thumpers'.

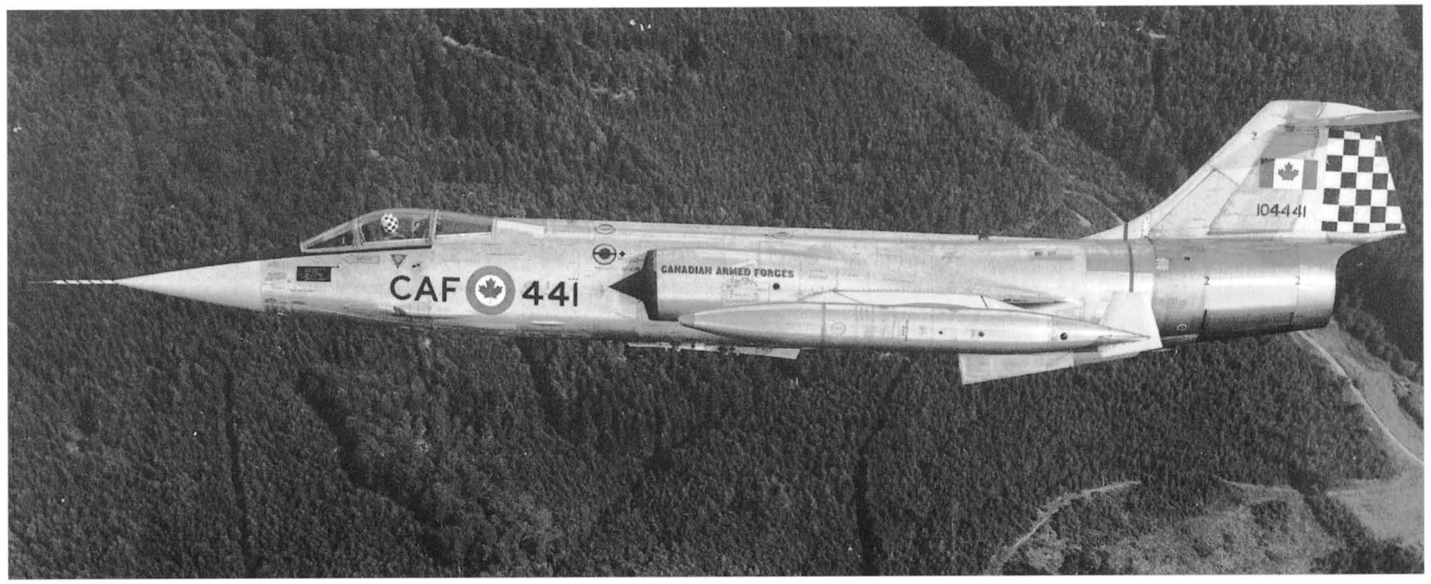
Now the 104 had explosive canopy jettison thrusters, rather phallic in appearance, mounted on each side of the canopy sill just about abeam the pilot's head. These thrusters would explosively blow the canopy clear of the aircraft in an emergency, or as part of the ejection sequence. The 104 also had a warning lights and horns test switch that illuminated all advisory, caution and warning lights in the cockpit, while making appropriate noises. The switch was replicated in the rear seat instructor's position of the two-seat trainer, and activation of this test function was a standard part of the pre-start check. Preying on student vulnerabilities, one instructor very early in the programme thought he would have some fun with his charge by reviewing the various idiosyncrasies of the aircraft and then suggesting that if the warning lights would not go out when the test switch was released, pounding either one's fists or another blunt object vigorously on the thruster would remedy the errant lights. In reality, the instructor simply held down his own test switch in the rear seat and did not release it when the student released his in the front, until a suitable display of strenuous physical activity had been elicited. The hardest part of this whole operation was keeping a straight face. Our groundcrew were wonderful and often reinforced the myth by either helping with the pounding or offering a substitute items such as the screwdriver to take the stress off the student's poor tired fist. We didn't manage to get everybody, but there were some memorable achievements, including general officers. Once an instructor found that he 'had a live one', this foible was judiciously reinforced by other instructors throughout the course, just to increase credibility. At the end of the course, the most deserving souls were awarded a trophy with a 'nice having you' caption, inducted into the

'Order of the Thruster Thumpers' and sworn to secrecy for all time.

Another idiosyncrasy of the aircraft created one of my fondest memories of the 104. There were just too many 'T'- and 'D'-shaped handles in the cockpit to activate various systems such as rudder pedals, canopy jettison, emergency hydraulics, the drag chute and a number of other items, and a *lot* of them looked uncomfortably alike. During September 1975, our squadron deployed for two weeks to Kleine Brogel, Belgium, while our runway in Baden, Germany, was being resurfaced. One day, I was leading a four-ship flight on a nearby bombing range and had a very senior squadron officer as my Number Two. I had already finished my post-start systems checks and was waiting for the rest of my flight to check in, when I glanced over at my Number Two just in time to see the drag chute come streaming out! Cunning devil that I am, I plumbed my brain to recall if this was a new post-start check procedure, knowing full well it wasn't. The next thing I heard was a meek little voice coming from Two (who didn't think I could see him) saying that he was having a 'small problem' and would have to abort. Later investigation on my part with the groundcrew revealed that this rather absent-minded senior had been adjusting his rudder pedals with the drag chute handle! To make matters worse, 'our hero' reputedly attempted to hush up this minor embarrassment by offering the groundcrew a keg of the finest Belgian beer if they would keep a lid on the event. Being both enterprising and honourable chaps, they agreed, took the beer and then, because the story was just too juicy to suppress, promptly blabbed it all over Western Europe! The fall from grace in the hero trade can be swift and brutal!



**CAF CF-104 104810 with practice bomb dispenser on the centreline. On 28 February 1968, the RCAF became a part of the Canadian Armed Forces (CAF) and all aircraft were painted with the letters 'CAF' in place of the old style 'RCAF' lettering on the forward fuselage. Canadian Starfighters also had the prefix '104' inserted in front of the serial number on the tail.** via *Aeroplane*

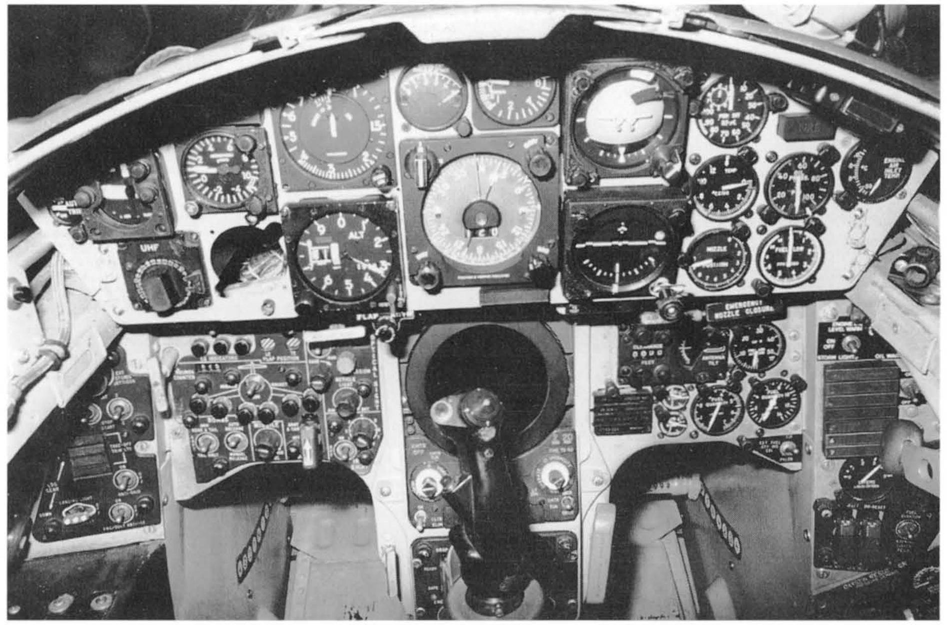


**CF-104 104441 of No.441 'Silver Fox' Squadron, RCAF.** Andy Graham via Steven M. Fochuk

## Tactical Considerations

Because the flying weather in Central Europe, the most common home of 104 operations, can be particularly grim, the aircraft had to be optimized for instrument flying. Although navigation aids consisted merely of the inertial navigation system, TACAN, and, to a certain extent, the ground mapping radar, the instrumentation itself was first class. Although it didn't have a Horizontal Situation Indicator (merely a bearing pointer and Distance Measuring Equipment) the attitude indicator in the Canadian version made up for it. It was an enormous 5in sphere, grey over black with the compass headings etched in the sphere itself, and it was your 'own little world'. It really spoiled you on Ground Control Approaches to minimums in particularly rotten weather. The Rhine Valley was especially bad in winter, with half-mile flight visibility being routine. Needless to say, at final approach speeds in excess of 180kts one's flying had to be precise and accurate.

***(Above)* CF-104 104799 with Vinten Vicon photo-reconnaissance pod with four 70mm cameras on the centreline pictured on 13 February 1969.** Andy Graham via Steven M. Fochuk



**F-104G instrument panel.** DaimlerChrysler Aerospace

The inertial navigation system was a very primitive variant, although it was the last word when it emerged. We used to joke that the hamsters were getting tired out on the treadmill when it acted up, which was often. Later, it was replaced with the excellent Litton LW-33 system during the aircraft's twilight service years.

The F-15A radar (not to be confused with the F-15 Eagle) had both air-to-air and air-to-ground modes. Although the air-to-air mode was extremely primitive by today's standards it was still a useful tool in the hands of a skilled operator. However, the air-to-ground radar was really first class. Raw as opposed to processed radar returns were provided, so one had to become good at interpretation, but once this was mastered, you could navigate (and even bomb) off it with a very high degree of accuracy. Unlike synthetically processed radar returns, which can look like a photograph, the F-15A radar in a ground-mapping mode was only straightforward when flying over large lakes, coastlines or large, distinctive cultural centres such as cities. At other times, such as flying over mountainous terrain, one had to take such items as the radar's line of sight and subsequent impact on the scope presentation into account. Good radar navigation in the CF-104 was quite an art form.

The low-level characteristics of the Starfighter were incomparable. Due to its exceptionally clean lines, it created very little form and parasitic drag and the high wing loading, although detrimental in hard-turning air combat engagement, ensured an extremely stable flight at high speed 'on the deck'. In fact, the 104 cut through turbulence like the proverbial hot knife through butter. The air-minded German public loved the aircraft. Since so many NATO nations including Germany flew the 104, I think she became a symbol of the Alliance to them. However, adverse publicity during the high accident rate period of its career was extensive enough to inspire the Teutonic sense of humour. They joked that if you wanted to own a 104, just buy an acre of land anywhere in Germany. Sooner or later…

At any rate, when all was working properly, the airplane did outstanding work in the low-level high-speed environment. When it didn't, you had to think fast, since the 104 had the glide ratio of an anvil strapped to a manhole cover.

A friend of mine is the source of one of my favourite 104 stories. He was motoring along at low level one day in the Moselle area of Germany when he suffered a catastrophic bird strike that totalled the engine, necessitating an immediate ejection from the doomed machine. Apparently, every warning light and horn in the cockpit came on. His statement to the accident Board of Enquiry is a classic: 'I looked inside the cockpit, saw all those pretty lights and just *knew* I'd won a hundred free video games, but didn't think I'd hang around to play them.'

Night flying was downright pleasant in the 104, with good cockpit lighting and excellent visibility. The Canadian version had completely red cockpit lighting, and I remember being bitten by that once on a night low-level radar navigation route. I had marked some reference lines on my map in red ink. I soon found out that the net effect of red lines under red lighting was invisible lines. Brilliant. The GAF/USAF version had more conventional white lighting. Night formation was a rather dicey business on a dark night since there was no strip lighting and what external lights that were available were very limited. What lights we had consisted of white, amber, red and green ones strategically located on the sides of the fuselage and either on the wingtips or on the tip tanks. The trick was to arrange all these lights into some predetermined geometrical pattern when nothing else was available. Night formation takeoffs and landings were not normally a

***(Top)* CF-104 104776 with Vinten Vicon photo-reconnaissance pod with four 70mm cameras on the centreline.** Andy Graham via Steven M. Fochuk

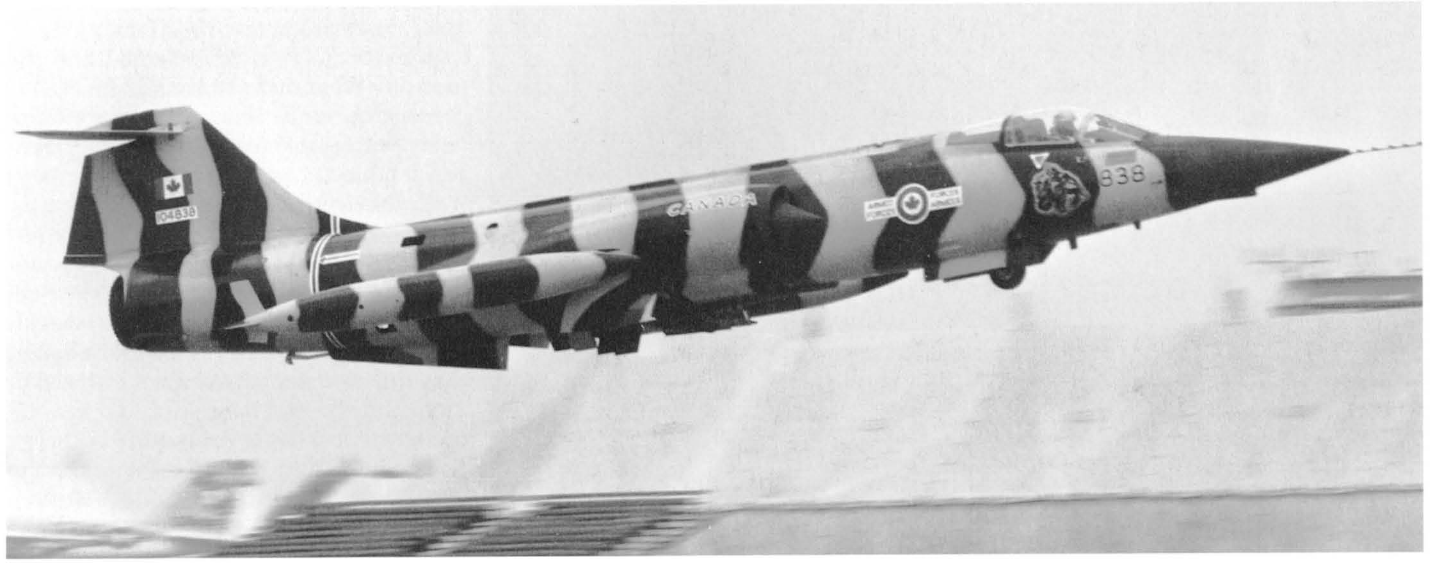
***(Middle)* CAF CF-104 104743.** Gordon Bain via Aeroplane

***(Bottom)* CF-104 104855 of the RCAF.** Andy Graham via Steven M. Fochuk problem though. On takeoff, the rosy glow of the aircraft afterburners provided a great deal of reflected light, although it sure could get dark in a hurry when afterburner was deselected. In a landing configuration, the lead aircraft's landing lights tended to bathe his machine in enough light to provide easy reference to normal daytime formation hues. An afterburner takeoff at night was a treat to the eyes. The rosy glow of the afterburner plume, which extended 30–40ft behind the aircraft was evenly interspersed with white shock diamonds of hot gasses. Very impressive.

Over the years and in service with various nations, the 104 acquired various different forms of camouflage warpaint. However, the Arizona birds spent their lives in natural aluminium and two of them were what we considered our airshow steeds, the ones we most liked to show off. They were actually used in the F-104/Yeager spin sequence in the movie, *The Right Stuff*. One of the crew chiefs was a fanatic. He continuously polished the jet with jeweller's rouge; he even shone the nozzle feathers of the tailpipe after landing. This guy used to walk behind you with a rag and scowl at pilots who put fingerprints on his beloved during the pre-flight walk-around. We used to call it 'the grape' in air combat training, since it was so shiny it could be seen for miles earlier than anything else, and the guy flying it tended to get eaten alive during those close encounters of the finest kind.

In Air Combat manoeuvring (ACM), the aircraft displayed limited turning capability due to its high wing-loading, but *great* acceleration. Only the F-105 and perhaps the F-111 were in a similar wing-loading league with the 104. Almost all the other fighter or fighter-bomber types with which we routinely practised ACM tended to have much lower wing loading. We would capitalize on the aircraft's aerodynamic properties with 'hit and run' type tactics, not allowing ourselves to enter a hard turning engagement with a superior turning fighter. Although an occasional deviation from this norm by a highly experienced air combat pilot to capitalize on an adversary's mistakes was possible, in most cases, violations of the hit-and-run principle resulted in a severe drubbing for 104 pilots. 'Turning and burning' was just not its forte. It took acres of airspace to turn the jet around at combat speeds and it's no wonder that ex-104 pilots who now fly the redoubtable CF-18 Hornet have likened this worthy successor's close-in, hard-turning fighting capabilities to 'a knife fight in a telephone booth'. Still, the 104 could turn where we needed to turn, down in the high-speed, low-level environment, and this was due to the better turning and engine performance in the denser air at lower altitudes. Few people realize that a 'clean' 104 below 5,000ft MSL in full afterburner could *sustain* a seven 'G' turn. The trouble was, in full burner, you couldn't sustain it very long before you ran out of gas, fuel flows being *very* high at low level. A typical ACM mission might not last more than 30–40min, of which perhaps only about 10min actually involved combat. With less than 6,000lb of fuel in a typical ACM configuration and a fuel flow rate probably 8 or 9 times that in pounds-per-hour (PPH) in afterburner, one does not have to be Albert Einstein to realize why fuel control was (and is) such an essential element of air combat.

**CF-104 104706 of the RCAF in the later-style camouflage.** Canadair

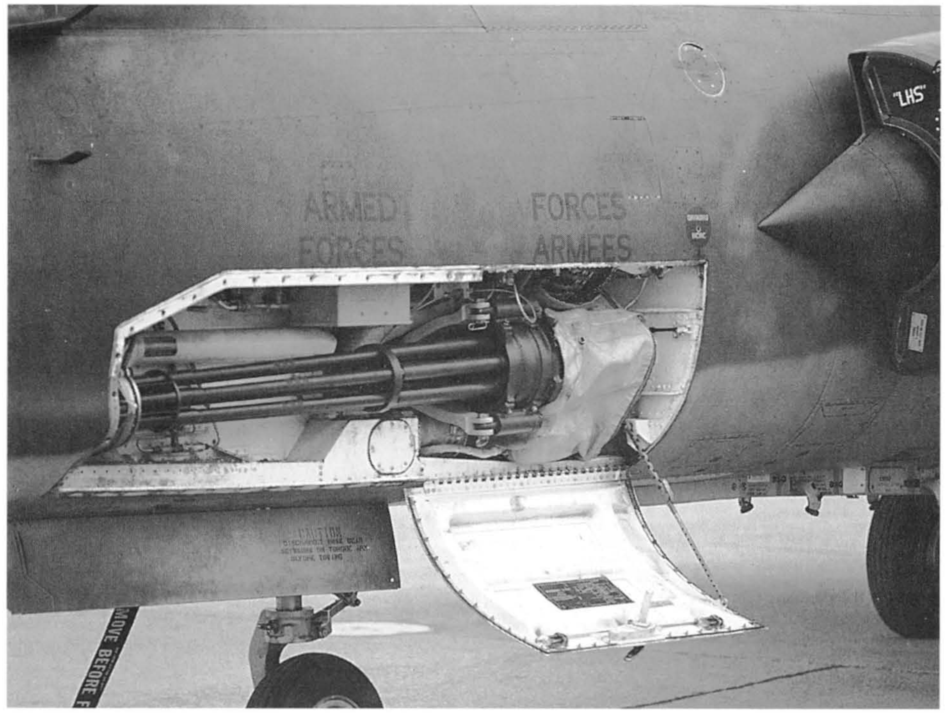


***(Top)* CF-104 12838 of No. 439 'Sabre Toothed Tiger' Squadron in yellow and black Tiger scheme striping at the 104 'meet' at RAF Greenham Common in the summer of 1977.** Air Portraits via *Aeroplane*

***(Bottom)* CF-104 12838 of No. 439 'Sabre Toothed Tiger' Squadron airborne from RAF Greenham Common in the summer of 1977.** *Aeroplane*

In this day and age, sophisticated weapons systems such as those on the CF-18 and the Panavia Tornado can deliver all types of ordnance with utterly reliable accuracy, with varying degrees of automation. The 104 was very much a manual system, where individual pilot skill determined the outcome of each and every bombing, rocketry and gunnery event. Recent strides in weapons delivery technology are marvellous – a real aid to the fighter pilot, but we developed a tremendous sense of accomplishment in honing our skills on the 104 in manual release modes. We got *very* good, and also very competitive. Canadian 104 pilots did very well in international NATO bombing and gunnery competitions during the aircraft's heyday. Although I'm sure Kelly Johnson at the outset never envisaged this beautiful aircraft as a bomber, the excellent high-speed, low-level characteristics of the jet made it a rock-solid, stable platform for delivering various types of ordnance. Unfortunately, about 4,000lb of conventional munitions was about the most she could reasonably be expected to carry.

Typically, our deliveries tended to be low and fast, allowing minimum exposure time, this in deference to anticipated heavy enemy defences in the Central European scenario, and the typically low ceilings and reduced visibility of the sodden, pewter skies prevalent in this part of the world. Delivery parameters usually varied from level up to 10 degrees of dive and delivery airspeeds from 450–550+kt – the faster the better. We used to have an elaborate betting system for quarters or German marks on the results of a lot of our bombing range missions. For example, each bomb dropped or rocket fired and best overall score with the gun would be worth a quarter. This is not to imply that our fighter pilots were a bunch of high stakes gamblers – very little money actually changed hands when you consider a typical range mission would mean about six practice bombs dropped, three or four practice rockets fired, and several gun passes. Furthermore, it was unusual for any one individual to 'sweep' the competition. Anyway, rivalry was often fierce amongst the experienced, and I can remember days when four or five 'bull-eyes' or 'shacks' (direct hits) were not good enough to finish you in the money. (Gary, if you are reading this, you *still* owe me 50 cents.) Not bad, when you consider that anything inside about 140ft was a qualifying bomb. You had to be good, or there went the kid's lunch money.



**Close-up view of the M61 cannon mounted on a CF-104G pictured at Oldenburg on 10 November 1984 on the occasion of** JaboG43's **25th F-104 anniversary celebrations. After the Canadian government's rejection of the nuclear role in 1968, CF-104s were assigned to conventional ground attack and in 1974 the M-61 cannon was installed.**
Matthias Vogelsang

Unfortunately, the 104 garnered a reputation over time as a 'killer' aircraft, and it is time that this unfair reputation was put squarely in perspective. In fact, it was an extremely honest aircraft and as long as it was flown within the boundaries of its flight envelope and was treated with respect, it was utterly dependable. When the 104 entered service with NATO in the early 1960s, the technology afforded by the aircraft was a quantum leap over the earlier vintage jet aircraft then in service, and it took some time for the operators and maintainers to come to grips with this new technology, and the unique demands it made on pilot and technician alike. The Canadian accident rate is comparable to that of the other NATO members who operated the 104. Although 113 of the 238 CF-104s produced were destroyed in accidents during its Canadian service, it must be remembered that this record represents 25 years of continuous service in a very demanding environment. Thirty-seven Canadian pilots forfeited their lives on CF-104 operations. Needless to say, this record says a great deal for the escape system of the aircraft, and there were a great many successful ejections, even in marginal conditions. The biggest accident cause factor was the role to which the jet was exposed – the high-speed, low-level arena where opportunities to err are legion. Since the jet was only equipped with one engine, if you *lost* that engine at low altitude, you were in a world of hurt.

Some years ago, I reviewed all the 104 accidents that had occurred in the NATO consortium and it is truly amazing how few were attributable to unexpected mechanical failures. Most took place in the 104's early service days when various teething troubles were being ironed out and the aircraft experienced a rash of recurring catastrophic engine failures due to bird strikes at low level. It wasn't a devious airplane. It just demanded respect, and punishment for a major transgression was often swift and fatal. By and large, 104s did not kill pilots. Pilots killed pilots and 104s.

In the spring of 1986, the Canadian Armed Forces retired the Starfighter from its inventory. The rest of NATO (with the exception of Italy) has followed suit and the aviation world is a slightly sadder, lesser place for her passing.

Thanks for the memories, Kelly Johnson.

CHAPTER SEVEN

# Winning Their Spurs

*'No matter what you call her, "the F-104", "one-o-four", the "missile with a man strapped to it", she was quite an aircraft! A mistress, a temptress, she could lure the Belgian Starfighter pilots from a warm hearth, soft arms, hobbies, week-ends, and even holidays, if she was "available" to be flown.'*

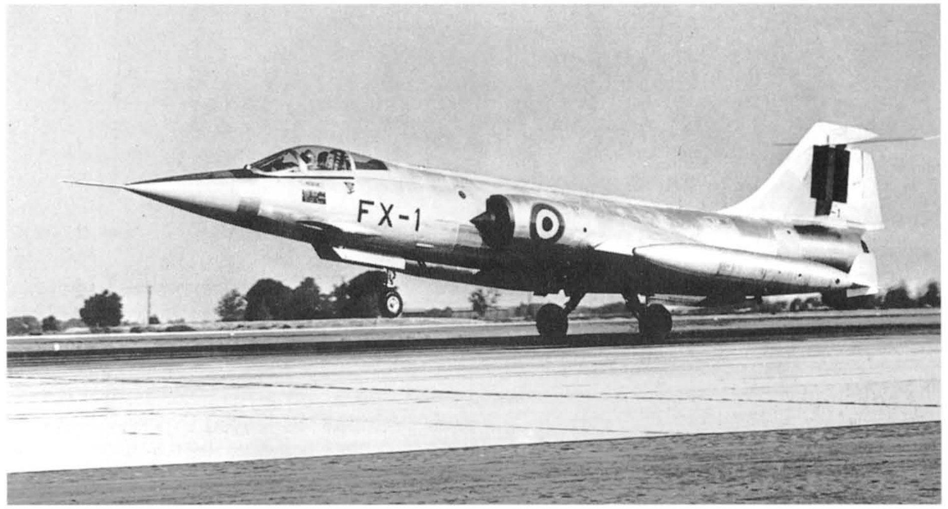
ADC (Adjutant Chef, or Warrant Officer) Jan Govaerts,
*350ème/1 Wing*, a 2,500-hour veteran Belgian Air Force F-104 pilot

## A Force to Reckon with

The *Force Aérienne Belge* (FAé)/*Belgische Luchtmacht (BLu)* received one hundred F-104Gs, and twelve TF-104G two-seaters for initial training and instrument ratings. Jan Govaerts recalls that the Starfighter:

> whatever she was called or whatever people thought of her, depended on what colleagues were flying – aircraft such as Fougas, Marchettis, Alpha-Jets, Mirages or transports. Mirage pilots regarded the F-104 Starfighter with disdain. Some of the Training Command instructors thought that to be threatened with a tour on F-104s was worse than being assigned to the salt mines!

Typically, the Belgian Starfighters of *349 escadrille/smaldeel* (squadron, or *ème*) and *350ème* of *1 Wing de Chasse/1 Jachtwing* at Beauvechain/Bevekom, and *23ème* and *31 ème* of *10 Wing de Chasseurs-Bombardiers/10 Wing Jager-Bommenwerpers* at Kleine Brogel, were very adaptable. They were used in the fighter role as well as the fighter-bomber role. This way the aircraft and their very expensive equipment were never idle. It is interesting to note that the electronic equipment represented about 40 per cent of the total cost of the aircraft. The total cost of a F-104G at that time was 108 million Belgian francs. For a TF-104G Belgium had to pay 110 million Belgian francs.



**FX-01, the first F-104G for the** Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu), **balancing gracefully on its main gear during a landing roll, touches down after a routine test flight at Lockheed's desert jet base at Palmdale, California on 14 November 1961. This was the only Belgian F-104G to be produced and assembled by Lockheed. FX-01 was issued to** 350ème/1W **on 14 February 1963 and was used as instructional airframe at Saffraanberg from 1966 to March 1968. FX-01 had an eventful flying career. On 5 June 1969 the main gear collapsed during taxiing at Bitburg and on 1 July 1970 it undershot the runway at Beauvechain. At Capois-Leignon near Ciney at 10.30hr on 26 January 1971 it became the third and last Belgian Starfighter lost as a result of 'pitch-up' when Captain Luc Declerck of** 350ème **had to eject. The Starfighter crashed in open country and Declerck suffered back injuries.** Lockheed

> Lt Colonel Steve Cailleau became the first Belgian pilot to fly solo on the F-104G, at Edwards AFB, on 24 June 1961. Two years later, on 18 April 1963, Lt Col Cailleau, the *1 Wing de Chasse/1 Jachtwing* commander, landed the first F-104G (FX-04) at Beauvechain. Next day Major Marcel Legrand, *350ème* Commander, made the first flight from the base, in FX-04.

Jan Govaerts recalls:

> All through the years the Starfighter acquired for itself the nickname 'widow maker'. In West Germany Inspektor-General Johannes Steinhoff of the *Luftwaffe* called the 104 'a most exceptional aircraft'. Germany, one of the great users of the plane, put some 916 Starfighters into the line, but lost 270 of them in crashes, killing 110 pilots. A sorrowful record but they were not alone.
>
> The *Force Aérienne Belge* (FAé)/*Belgische Luchtmacht* (BLu) had to recruit pilots to fly the Starfighter, which, as the Chief of Staff pointed out, was 'a very sophisticated aircraft with lots of electronics and so complex we can put this aircraft only in the hands of experienced pilots'. And this was why the first requirement to fly the Starfighter was 2,500 flying hours on jet aircraft. So far so good, but with all the polemics in the press and the fact that not all the Belgian pilots available were eager to fly an aircraft with such

**F-104G FX-05 was taken on charge (TOC) at Gosselies on 21 May 1963 and issued to** 350ème/1W. **In November 1963 it was transferred to** 349ème **where it was flown without mishap until 20 June 1968 when it was lost at Samrée-Dochamps after a power loss during a return flight from Bitburg to Beauvechain. Commandant Henri Vandegaer (Wing Ops) ejected successfully.** Jan Govaerts

a background, the *BLu* was running short of candidates. This then was the main reason why the Tactical Air Command decided to recruit non-commissioned officers (NCOs) to fly the F-104! In 1963 an effort was made to stop recruiting NCO pilots. One general said that the 'IQ' of the NCO was not high enough to master an aircraft like the Starfighter. Another general said 'An NCO pilot flying one of my Starfighters – over my dead body!'

At first, starting in 1963, Belgian pilots were trained at GAF Nörvenich air base near Cologne. Later on, in 1964, Belgian pilots like myself received their training in the *Waffenschule 10* at GAF Jever, after having passed the ground school at Twenthe, in the Netherlands. The aircraft used were the F-104F and, from 1965, the (T)F-104G. The first one was really a flying rocket for high-speed performance. It had a limited instrument panel, no sophisticated electronics, and no external load could be put on the wings. The second one permitted us to fly on instruments! Each pilot flew seven transition stages totalling six and a half hours and included a supersonic flight lasting 45 minutes, instrument and formation flying, a Mach 2 run, and a solo test flight before soloing.

The Mach 2 run used up much fuel! The F-104G started with 5,825lb but after start-up, taxi and run up, just 5,400lb remained and after take-off, acceleration on full power to 450kt (in 60sec), fuel remaining was 4,830lb! Climbing on maximum power at 450kt until Mach 0.9 and maintaining this speed until 36,000ft (time, 95sec) used up another 700lb. After accelerating to Mach 2 at 36,000ft fuel remaining was 2,705lb. Flying at Mach 2 at 36,000ft for 2min would leave 1,465lb remaining (at 50,000ft the time would be 4min for the same fuel consumption). Returning to base at economical speed left 715lb of fuel remaining and a missed landing, overshoot, then landing, would leave 215lb of fuel remaining.

Following successful completion of the seven transition stages the pilot then joined either *349ème* or *350ème* to begin transition training on the F-104G (ten missions), followed by a radar transition (plus or minus ten missions), after which he attained operational status. When Belgium got its two-seaters, in 1966, *1 Wing de Chasse/1 Jachtwing* at Beauvechain began its own conversion unit called the 'Flight-TF', followed by *10 Wing Chasseurs-Bombardiers/10 Wing Jager-Bommenwerpers* at Kleine Brogel. All technical information was then given by the Technical School at Saffraanberg near St Truiden. When we started with our own 'Flight-TF' we used the same programme for new pilots with more than 2,500hr jet experience, and in the case of those with less than this requirement, twelve transition flights.

In 1967 transition of the pilots to (T)F-104 instructors began. In 1968 instrument rating was accomplished in the (T)F-104. Previously, it had always been done on the T-33 Shooting Star. In the early seventies, when we had very young pilots with an average of 300 hours' flying experience, we intensified this programme with more formation instrument flying and radar handling. As such, the pilot arrived in the squadron ready to start his operational transition with 40 hours' F-104 experience.

**F-104G FX-16 near Wavre in the vicinity of Beauvechain in 1965. This Starfighter was TOC at Gosselies on 17 October 1963 and was issued to** 349ème/1W. **It suffered an in-flight fuel leak on 15 July 1964 but Adj H. Nuyens landed without injury. On 14 December 1966 FX-16 was lost after experiencing 'pitch-up during a circuit. Major Emanuel 'Manu' Kennes, CO** 350ème/1W, **ejected unsuccessfully and was killed.** Jan Govaerts

In the whole of my career (ten years instructor on F-104s), we experienced a few things that did not go right for four student pilots. One was a former fighter-bomber pilot who never did fly solo on the F-104. Pilot number two was a former instructor who ejected from a Starfighter during his training and who then decided to resume his career as an instructor! Pilot number three walked up to me after a formation training exercise and told me frankly, 'This is it. I can't follow it as it is too difficult for me.' I appreciated this very much since he was honest!

Pilot number four was a former member of the 'Red Devils' on Fouga Magisters and an instructor. He was posted to 1 Wing but did not like flying the Starfighter. We soloed him for flying in the F-104 at night. The weather conditions were ideal but his recovery using GCA wasn't! He was too high on the glide path and the controller gave him the call to overshoot. Panic-stricken, he continued on regardless and put his aircraft on the runway too steep and too fast. The undercarriage completely broke off and the Starfighter skidded along the runway on its belly. The amazing thing was the following day we looked over the runway and there was not a trace of a skid! The crippled one-o-four had skidded on the white centreline for about 8,000ft without leaving any marks whatsoever. Only when the speed had slowed did it leave the centre line in a shallow turn, to come to a stop close to the grass. The F-104 burst into flames and the minute the fire crew arrived, the ejection seat fired. The poor pilot fled in shock and some 500yd away, stopped at the Louvain–Namur road waving his arms in the air. A driver stopped and picked him up and returned him to the base. The driver was a former fighter pilot who had been a member of *1 Wing*!

Capt Georges Castermans was the first Belgian pilot to eject from a F-104, when he banged out on 16 July 1963. Bernard Neefs, the SABCA production test pilot, also had cause to eject, when he did so during an acceptance test on 21 November that same year.

Jan Govaerts remembers the production test pilot:

He was one of the first three Belgian pilots to qualify on the Starfighter in the USA and soon after left the Air Force to become a test pilot. As a member of the Auxiliary Squadron he was permitted to fly at week-ends and even during week-days.

One day he flew an operational mission with *350ème/1W*. Two pairs of F-104s took off for a sweep over Belgium. The first pair was composed of Capt Marcel Vanderstockt and Bernard Neefs was his wingman. The second

350ème **exchange with** Armée de l'Air **Mirage III squadron at Dijon, France, 13–23 September 1966.** ***Standing, L-R:*** **Ludovic Forgeur, record holder for Belgium with a climb to 82,500ft (25,146m) in a Starfighter; Jean Vanhaesendonck, last NCO pilot to leave the** Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu) **on 31 March 1987; Georges Goussens, a member of the team that won the Air Defence Competition on 21 September 1965; ADC Jan Govaerts; Fernand Dasseville, TF. Flight Commander.** ***Kneeling*:** **Jack Lehardy, flight commander, and Willy Van de Perre, an ex-**BLu **Mosquito and Meteor NF11 pilot.** Jan Govaerts

***(Below)*** 350ème/1W **exchange with** 9° Gruppo, 4° Stormo 'Amendo d'Aosta' AMI**, at Cameri, Italy.** ***Back row, L-R:*** AMI **PR officer; Geroges D'Hert,** 350ème **operations officer;** AMI **pilots; Georges Castermans, CO,** 350ème**, the first Belgian pilot to eject from a Starfighter (FX-08 on 16 July 1963),** AMI **pilot.** ***Kneeling:*** **Jan Govaerts between two Italian pilots.** Jan Govaerts

**(T)F-104G FC-06 flown by student pilot André Desmittere with instructor, Leon Hanson, in the rear cockpit in the circuit at Beauvechain at 2,500ft (762m). FC-06 was TOC at Gosselies (it was registered FX5103 during SABCA test flights (and issued to** OCF/10 Wing **on 18 December 1967. This Starfighter was last used by** 31ème/10W **on 1 July 1982, being withdrawn from use (wfu) and stored on 16 February 1983. It was struck off charge (SOC) in January 1987 and sold to Radcomm Enterprise for shipment to Taiwan in October 1990.** Jan Govaerts

> pair consisted of ADC Willy Van de Perre and myself. The weather at take-off was not good and we were expecting very bad visibility with haze. Shortly after take-off we were informed that the weather over Beauvechain was rapidly deteriorating from a 'green' airfield state to 'yellow'. The two pairs rejoined the overhead position and since Mister Neefs was not used to flying in marginal weather conditions, Willy and I decided to let the other pair land first. The weather by now was really deteriorating and the control tower people suggested that we descend individually! Neefs went in first, followed by Vanderstockt. Both landed safely on Runway 04 left. When I started my letdown the weather state changed to 'amber'. While in the GCA approach and committed to landing, the state changed again, this time to 'red'! Thanks to my knowledge of instrument flying and experience in bad weather conditions, I made the runway alright and landed safely.
>
> Willy Van de Perre was next and he was told he could have only one try. Visibility was practically nil thanks to the haze. Poor Willy missed the runway and he had to overshoot. By this time his fuel state was so low that he told GCA that he was, 'Pulling up and bailing out!!!' As he reached 2,000ft, the Kleine Brogel GCA, on stand-by to help Beauvechain, told Willy, 'We have definite contact with you. Fuel permitting, come in and land here. Our weather state is still "yellow". Van de Perre set course for Kleine Brogel and landed there without further incident.
>
> Later that day, when the weather improved again, Willy Van de Perre flew his F-104 back to home base where he received a serious scolding from the wing commander, Lt Col Marcel Legrand. The CO said, 'You should not have said that you were pulling up and bailing out!' Willy was really flabbergasted. After saving a valuable aircraft he was not even worth some sort of congratulation.
>
> When I reached the dispersal after having parked my aircraft I entered the pilots' room and saw my friend Bernard Neefs trying to drink a cup of coffee. I asked him, 'How did it go?' He looked at me and replied, 'You know, it scared the hell out of me. From now on I have the utmost admiration for you fighter pilots flying in weather like this. Never again. I will stick to flying at my test unit with 'blue' conditions – unlimited visibility and no clouds!' This was the last time we ever saw Bernard Neefs on the squadron. On 7 November 1965, the same year the above story happened, he crashed in a light aircraft at Genes, Italy, and was killed.

On 30 April 1964 His Majesty King Baudouin paid an official visit to *1 Wing de Chasse/1 Jachtwing* at Beauvechain and he received his pilot wings from Lt Gen Jan Ceuppens, Chief of Staff, Belgian Air Force. Twelve years earlier, HRH Prince Baudouin, as he then was, had been taken aloft in a Meteor Mk.7.

On 18 August 1964 Capt Pierre Tonet became the first of twenty-four Belgian pilots to be killed flying the F-104, when he died after entering a loop during a test flight at SABCA Gosselies. The first squadron pilot to die was Capt Jacques Verhulst of *31ème*, on 27 January 1965.

On 21 September 1965 the Air Defence Competition saw the first participation by *1 Wing de Chasse/1 Jachtwing*'s Starfighters. The team, which was led by Capt Castermans, and composed of Capt Piet Hallaux and Capt Emiel Baestaens, and five non-commissioned pilots; ADCs François Bodart, Leo Mommens, Georges Goussens and Thierry Grisard, took first place. Altogether, twenty-nine ADCs (non-commissioned officers – including ADC Jan Govaerts, the first Belgian pilot to log 2,000hr on the F-104, on 24 February 1975) flew the Starfighter in the *1 Wing de Chadde/1Jachtwing* at Beauvechain and sixteen in *10 Wing Chasseurs-Bombardiers/10 Jager-Bommenwerpers* at Kleine Brogel. All of them had more than 2,500 hours' jet experience, which was quite normal since they were never called away to a desk job. It is remarkable that none of the forty-five non-commissioned officers who flew the Starfighter were killed. In 1965 NCOs were no longer recruited into the Belgian Air Force. (The last two were pensioned off on 31 March 1987!)

### *Corsican Interludes*

There were other highlights in the 1960s. On 12 October 1965 the first air-to-air firing took place at Solenzara in Corsica. Jan Govaerts recalls:

> In the early days of the Starfighter we had to qualify pilots in shooting air-to-air and air-to-ground. The air-to-air period took place annually in Corsica on a North–South axis east of the island. One month before going abroad every squadron had to exercise the pilots on the targets with the ciné-gun camera above a more or less deserted area of Belgium.
>
> For air-to-air we commonly used a towed flag as a target with the Meteor and other jets, but in 1965 we were going to make use of a new system, known as the dart. At the time we did not know that it was going to be such a pain in the a…! It was some sort of 'tetrahedron' fitted to the port wing. Next to it was a pylon tank in which the release mechanism was housed with 1,500ft of cable. Extra fuel was carried in a tank under the starboard wing. The four wings of the dart were made of plywood covered by metallic sheets to reflect radar, in order to be able to lock on the target before shooting our Vulcan gun. Once in the air there was no danger of hitting the towing aircraft since the weight of the cable and the dart combined put it much lower.
>
> Due to its position, the dart could move up and down a few inches, and ground clearance was such that care had to be taken on the take-off run. The F-104 with a dart on the wing was limited to 15 degrees of flap (a mechanical stop on the flap lever reminded the pilot that using full flap was impossible!). this meant that the take-off had to be calculated to the 'nth' degree in a rather flat attitude! If we didn't, the dart fins would touch the ground and pieces fly off.
>
> On 12 November 1965, Capt Georges D'Hert took off and pieces of one of the fins went straight through the gap between the wing and aileron. The shock to the system was such that the dart failed to reel out!
>
> Once safely airborne, the pilot flew to the towing area, reeled out the dart and the F-104s could start their exercise. On return the tow-ship had to fly at 1,500ft parallel to the runway to release the cable and permit the dart to fly into the ground. Mostly it did not skid down but crashed, which made it difficult for the armament officers to check if any scores were made on the fins with coloured 20mm ammunition.
>
> During four gunnery periods in Corsica I towed twelve times, and six were successful. For example, on 27 October 1966, when I reeled out the dart, a hook came loose and flew into the rudder of my aircraft. Another time the reel-out was successful, but once behind the aircraft, the dart started performing barrel rolls. Landing was another thing. Since we could not lower full flap we had to fly a higher approach speed – instead of the normal 175kt we had to increase this to 195kt plus fuel reserve, 5kn/1,000lb of fuel. Returning with 2,500lb fuel left, the airspeed had to be 210kt. The standing order therefore was 'No landing with the dart!'
>
> On two occasions in Corsica, the blasted thing did not come out and on 19 October 1965, Willy Van de Perre had to drop the whole system on the beach. Next day I experienced the same problem and I had to drop the system too. Some days later back at Beauvechain Capt Min Degraeve landed successfully with a hang-up. It was then decided that if they had a hang-up, experienced pilots could land the tow-ship with the dart still attached. On a later occasion an inexperienced pilot was mistakenly told to tow the dart. On the way out to his Starfighter the strong wind whipped his notes for dart towing off his kneepad. He recovered the notes but they were now out of sequence. The first action should have been 'Reel out the dart', 'troubleshooting when stuck etc', and finally, 'emergency drop of the system'. Instead, 'emergency drop of the dart' appeared first and one and a half hours later a valuable piece of equipment was dropped into the sea!

**F-104G FX-26 was TOC at Gosselies on 21 February 1964 and issued to** 349ème/1W. **After completing service with the** BLu, **FX-26 was acquired by the** Türk Hava Kuvvetleri (THK, **Turkish Air Force) on 17 May 1983 and was recoded '057' (later 4-057, 9-057 and 4-057).** *Aeroplane*

Peter Loncke, a F-104 ground technician, recalls:

> Most of the 10th Fighter Bomber Wing armament people came from the F-84F Thunderstreak to be converted onto the F-104 Starfighter. The leading edge of the F-104 wing was as sharp as a razorblade and more than once did I see people walk in with their forehead cut open after they had run into the wing! They used to load the .50 calibre machine guns in the nose of the F-84F, but the Starfighter, with its M61 Gatling Gun, was a plane out of the next century. The M61 gun was mounted in the left side of the Starfighter in front of the air intake and permitted easy access for maintenance. Compared to the .50s of the Thunderstreak, the M61 needed very little maintenance. The system had a built-in 'Gun Purge System' to blow out gases left by the fired 20mm rounds. This system took compressed air from one stage of the engine and blew all the gases out of the bottom of the gun compartment. To get the gun system operational you had to use 80 per cent

thrust from the engine. This was checked by the armament people each time an aircraft left the maintenance hangar after an overhaul.

One day in Corsica, one of the returning F-104s had a gun problem. The weather was not so good and it was late in the afternoon when the chief of the armament shop, ADC Cop, decided to check the system out on the flight line. He put on his raincoat and went to the aircraft, whose engine was already running. The pilot would rev up the engine to 80 per cent and fire the gun to see where the problem was. A voltmeter was connected to the firing contact of the gun to see if the 250 volt DC arrived at the firing contact. ADC Cop stood next to the gun in front of the air intake. (As all of this was done quickly, no intake covers were placed over the left air intake). The engine was using 80 per cent of its power and the Adjutant Chief standing next to the gun was sucked against the air intake! He lost his raincoat, and his false teeth! No other harm was done as the engine was shut down immediately. The engine was taken out and inspected for damage. They found his rain coat inside the engine but his false teeth were never found!

Also in Corsica (on 25 April 1978), one of the Starfighters (FX-35) went to the range and fired a 2.75in rocket at a ground target made up of old car tyres. The rocket hit one of the tyres and one of them went straight up in the air, right into the air intake of the F-104. It crashed into the Mediterranean. The pilot (SLt (Sous Lt, or pilot officer) Freddy Antheunis), who ejected, was rescued by a French SAR helicopter and arrived back wet but safe.

### *First Flight*

On 13 April 1966 the first flight of a (T)F-104G at Beauvechain took place with Capt Luc Declerck at the controls. Also, Capt Xavier Janssens flew Minister of Defence Charles Poswick in a (T)F-104G. On 30 January 1967 the first 'zoom' flight in Belgium took place when Lt Col Etienne Barthelemy, Wing Commander, *1 Wing de Chasse/1 Jachtwing*, reached 62,000ft (18,898m) in an F-104G Starfighter. On 14 March 1968 Maj Marcel Lamproye and Lt Col Etienne Bathelemy reached a record height of 80,000ft (36,288m) in a Starfighter. Two weeks later, on 28 March, this record was beaten by Cdt (Commandant) Ludovic Forgeur, when his Starfighter reached 82,500ft (37,422m).

**TF-104G FC-10 was TOC at Gosselies and issued to** OCF/1 Wing **on 1 March 1968. It was last used by** OCF/10 Wing **on 14 April 1981 and was withdrawn from use and stored on 6 November 1981. The Starfighter was finally SOC in January 1987 and sold to Radcomm Enterprise for onward shipment to Taiwan in October 1990.** via Philip Jarrett

**F-104G FX-10 and FX-07 of** 350ème/1W **in formation. FX-07 was TOC at Gosselies on 6 June 1963 and was finally SOC in January 1987 before being bought by Radcomm Enterprise for shipment to Taiwan. FX-10 was TOC at Gosselies on 8 July 1963 and was transferred to** 349ème/1W **on 10 April 1980. The Starfighter suffered an in-flight accident at Solenzara, Corsica, when it lost a flap. Slt Luc Van Landeghem, landed safely. FX-10 was flown to Koksijde on 5 February 1981 for storage and withdrawn from use. It was SOC in January 1987 and sold to Radcomm Enterprise for shipment to Taiwan.** via Philip Jarrett

## Orient Express I

Jan Govaerts recalls:

> In 1967, a Starfighter squadron exchange between *349ème* and a Turkish squadron at Mürted near Ankara was planned. To avoid problems, the Wg Cdr Flying sent two pilots – Major Georges Philippot and myself, both of *350ème*, on ahead on 7 March to prepare the groundwork. This was the first time that 1st Wing Starfighters had flown so far and it called for some intensive route planning. The two F-104s were equipped with only two extra fuel tanks.
>
> Our departure was delayed due to mechanical problems and we finally took off two hours late, at 1200 hrs. This meant that the local time in Turkey was 1400 hrs. We kept this in mind. We reached Grosseto near Rome after 1hr 50min flying time. Being in a hurry, we had not time to stop and eat, and took off again one hour later for Tanagra near Athens, a flying time of 1hr 40min. The Greeks were very friendly and offered us overnight hotel accommodation, but Major Philippot explained that we had to leave as soon as possible.
>
> We took off again and once we were above the Aegean we headed east at 30,000ft for Izmir on the Turkish coast. Far above the horizon we could see the first signs of sunset. What worried me most, given the tension between the two countries, was the handover from Greek radar to Turkish radar. We radioed 'Athena control, we are leaving your zone now. Thank you for your co-operation.' Next, 'Joker radar, this is Echo-Bravo 121. How do you read?' Silence! We verified our radio and frequency and repeated the message. Still nothing! Darkness was descending and I asked my boss to put his navigation lights on steady dim because from now on I was going to fly in close formation. We had about an hour to go, thirty minutes of which would be in darkness. From time to time we called 'Joker' radar, without success! Luckily, our LN3 navigation system seemed to be working nicely and it gave us accurate information about Mürted distance and heading. All this time we wondered if Greek radio had passed on our flight plan. (Much later we learned that the Turkish radar station normally closed down at 1715 hrs but left a watch to listen out on certain frequencies, including ours. The watch heard our frequent calls but did not speak English.)
>
> After one hour of flight with the last ten minutes in complete darkness, I began to wonder if we would have to bail out. We had only about 30 minutes' fuel left and no ground control. And, were Mürted expecting us? My total flying hours on the F-104 at this time was 353 and I prepared for the first time to eject. All of a sudden a heavenly voice on the earphones indicated that Turkish radar were aware that we were overhead. Then I noticed through the scattered low clouds a concentration of lights. It was Ankara. Even without control we could descend, aim for the capital, and from there fly on to Mürted. It was not difficult to pick out the airfield lights of Esenboga and I knew from the navigation charts that from there on in I had to fly in a westerly direction for Mürted. I called the CO and gave him my idea. His reply came back like a cold shower. 'We don't go down by ourselves. We need effective radar control!' I told him bluntly, 'If you don't go down, I will.' This seemed to convince him, and he proposed to follow me in close formation. Throttle back, speed brakes out, I started to descend towards Ankara. The Hell with ground control. We broke cloud and levelled off at 5,000ft.
>
> Mürted were expecting us, but not after 1700 hrs. Maj Bostan of the Turkish Air Force was waiting for us at Mürted but at 1700 hours had given up waiting for us and he drove home in his Volkswagen. On the road to Ankara he suddenly heard the unmistakable scream of the J79, jumped out of his car, ran to the nearest telephone booth, and called the Mürted control tower to tell them to turn on the runway lights. My greatest worry was the surface wind. Landing downwind in a Starfighter is not that easy! I hoped that if there was any wind, it came from the east. Another thing was a 7,000ft mountain nearby.
>
> We had made a thorough study of the local terrain before leaving homebase and this is what saved us. We turned on finals and landed without any problems. Minutes later we saw the flickering lights of the crash crew accompanied by a Volkswagen 'Follow Me'. On stopping engines we were surrounded by Turkish groundcrew whom we could not understand, but Maj Bostan arrived and talked to us in English. He welcomed us and was so excited that we had arrived at night, and with no control in a visual circuit. He even added that the pilots on the base never flew when there was more than 4/8ths cloud and avoided flying at night. Next morning we flew home via Tanagra, where the Greeks were amused when we told them of our experience with the Turkish Air Force!
>
> The mess at Tanagra was closed so we still had not eaten when we took off for Grosseto, Italy. Rome radar controlled us and steered us straight into a storm front with lightning, hail, snow and strong turbulence. Before entering the storm I went into close formation with Maj Philippot. Seconds later my Starfighter experienced a power loss. A split second look at my instruments revealed that the exhaust nozzles were wide open. I pulled my emergency handle to close them again and resumed my close-in position. The approach and landing at Grosseto continued without further problems and we landed safely. Finally, we were going to eat! However before I could enter the mess I was called back to the flight line. An Italian crew chief had checked my aircraft and found nothing wrong. Static electricity had caused the exhaust nozzles to open. We got airborne again and headed for Belgium. Halfway I changed frequency and asked the chief controller, a neighbour in married quarters, to do me a favour and ask my wife to prepare me a big juicy steak. I was starving!

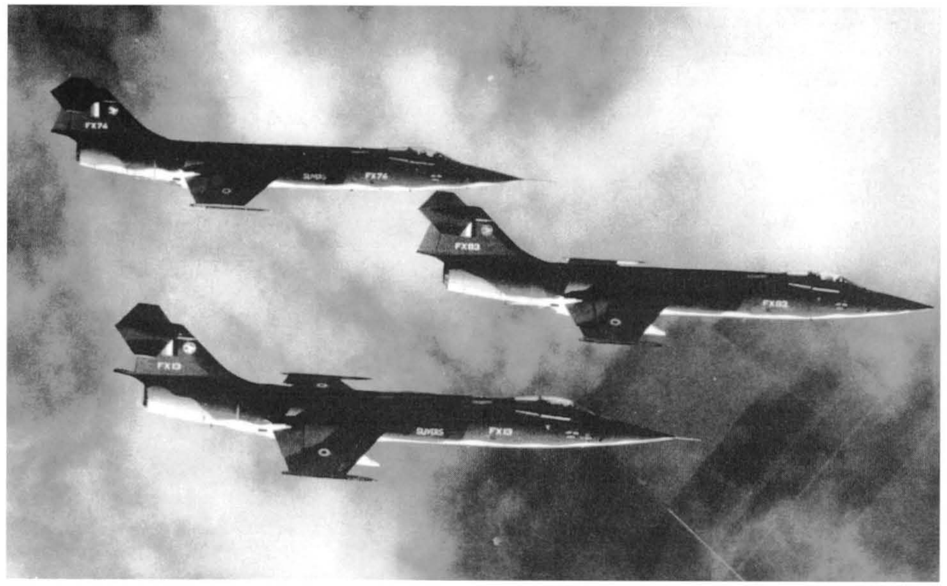
### *Crash on Take-off*

Jan Govaerts recalls:

> 10 Wing at Kleine Brogel never experienced a fatal or disastrous crash on landing!, but it had to endure two major crashes during the take-off run. Most of the time the F-104G fighter-bombers from Kleine Brogel had to take off heavily loaded, as required for their low-level mission. Four extra fuel tanks on the wings and a bomb dispenser did not make acceleration easy. Every inch of the runway was needed to get the Starfighter into the air. Runway markers helped the pilots to check their rotation and lift the nose off at the time to become airborne. On 4 April 1968 1Lt Leo Van Roy of *23ème* failed to lift off and he crashed at the end of the runway in FX-75 and was killed. During the war in the Belgian Congo, Leo had earned himself the nickname 'Death' because of his armed sorties in a T-6 Harvard against rebels.
>
> About a year after Van Roy's crash, on 24 September 1969, Capt Guy Ghijs of *31ème* also failed to lift off, in FX-71, but he reacted very quickly by using his ejection seat the moment his aircraft began breaking up. The seat went out at about 90 degrees. Separation occurred and luckily for Guy, he landed on water and his life was saved. Badly injured, he was confined to a wheelchair.

### *The 'Slivers'*

From 1 May 1969 the Starfighter display team known as the 'Slivers' began representing the Belgian Air Force and displayed at international and national air shows and 'open houses' in Europe. Beauvechain was represented by Maj Marcel Legrand, Maj Bill Ongena and Capt François Jacobs, while from *10 Wing Chasseurs-Bombardiers/10 Wing Jager-Bommenwerpers* at Kleine Brogel came Maj Hadelin D'Hoop, *23ème* commander (killed flying a Starfighter on 9 September



**F-104Gs, FX-74, FX-83 (piloted by Jan Govaerts) and FX-13 of 350ème/1W. (FX-13 and FX-84 were used by the 'Slivers' aerobatic team in 1973.) The photo was taken by another aircraft during a barrel-roll in close formation. The Starfighters are clean with missile launchers and pylon racks for fuel tanks. FX-74 was TOC at Gosselies and first issued to 31ème/10W on 9 October 1964. It joined 350ème/1W on 6 March 1969, finally being SOC in January 1987. Bought by Radcomm Enterprise, it was then sold to Taiwan in October 1990. FX-83 was TOC at Gosselies and issued to 349ème/1W on 6 January 1965. It joined 10 Wing on 27 June 1977, before being wfu and stored on 11 February 1982. Stripped of all useful parts, the remains were used at Florennes for aircraft battle damage repair (ABDR) from 15 July 1991 until February 1995, when the aircraft was stored at Weelde on behalf of the Royal Army Museum. FX-13 was issued to 350ème/1W on 9 August 1963. It was lost at Mellet/ Wayaux (Gosselies) at 1332hr on 12 December 1978 when it flew into the ground, killing Capt Martial 'Stony' Vansteenkiste.** Jan Govaerts

1965), Capt Kamiel Goossens, and Capt Wilfried De Brouwer. (The 'Slivers' gave their last performance on 11 July 1975.)

## *Royal Visit*

On 6 June 1969 His Majesty King Baudouin visited No.1 Fighter Wing at Beauvechain and expressed a wish to take the controls of a Starfighter for the first time. ADC Jan Govaerts recalls:

> It was not the fact that His Majesty wanted to fly the F-104 for a mission which included a high performance climb followed by a Mach 2 run that started a controversy, but the question, 'who is going to pilot the sovereign?'
>
> At this time the flight (T)F consisted of a commanding officer and four NCO instructors, so it would have been normal to take the expert pilot with the most experience, and that's where the 'shoe pinched'. ADC Leon Hanson was the most experienced but was refused because he was an NCO! So, the commanding officer of the flight, Commandant Leo Lambermont, was chosen. This caused yet another problem. He was a very skilled instructor on Stampe/Vertongen SV4b in the Elementary Training School and had taken command of the flight (TF) at Beauvechain two days earlier, and was not used to flying the Starfighter from the back seat. (T)F-104G FC-09 was going to be manned by the Commandant in the back seat with HM King Baudouin in the front seat. To make things easy for our sovereign, a second twin-seater (FC-01) was going to fly in formation with FC-09. This was to be flown by the wing commander, Lt Col Georges Castermans and myself.
>
> The weather was not too good with inversion reducing visibility to a minimum. The airfield state varied from amber to red but on top of the inversion, at 5,000ft, we would have clear sky.

**On 6 June 1969 HM King Baudouin (wearing sunglasses) flew a Starfighter for the first time. Here he is presented to his pilot, Capt Leo Lambermont. Col Paul Dewulf, Cdr 1 Wing, Lt Col Georges Castermans, Wg Cdr Flying 1 Wing, and Maj André Richir, 350ème CO, look on.** via Jan Govaerts

**ADC Leon Hanson secures King Baudouin's parachute harness. TF-104G FC-09 was manned by Capt Leo Lambermont in the back seat with HM King Baudouin in the front seat. To make things easy for the sovereign, FC-01, flown by the wing commander, Lt Col Georges Castermans and ADC Jan Govaerts, flew in formation with FC-09.** via Jan Govaerts

***(Far left)* Helped by Capt Leo Lambermont and Col Paul Dewulf, King Baudouin puts on his spurs.** via Jan Govaerts

***(Left)* King Baudouin prepares to climb aboard FC-09. Left is Colonel Paul Dewulf.** via Jan Govaerts

> After the pre-flight briefing we walked to our aircraft. The dispersal area was crowded with military personnel, journalists and high-ranking officers. Leon Hanson assisted HM with the strapping-in procedure and off we went.
>
> Take-off was made with full afterburner and we initiated a climb at Mach 0.92. At 5,000ft we were on top of the inversion and the deep blue sky was clear of cloud. At 36,000ft we turned left towards Bitburg, still in afterburner, and we accelerated to Mach 2. At this point Leo Lambermont got excited and called over the radio, 'The King is Mach 2. The King is Mach 2!'
>
> It was time to get out of the afterburner range and proceed to home base. There was very little fuel left since the twin-seater had no external tanks and had only 4,500lb on start up! The weather state did not improve and we made an individual descent with a GCA (Ground Controlled Approach) for landing. We were down again with a very happy King after thirty minutes!
>
> Col Paul Dewulf, the station commander, walked up to me and told me that he was very sorry that we NCOs could not participate in the reception in the officers' club. Thirty minutes later he called me and told me to hunt down some NCOs since there were not enough officer pilots available to present to His Majesty! Some time later twelve of us NCOs arrived at the officers' club. It was quite crowded and suddenly, the journalists and photographers were asked to leave the club and King Baudouin then asked the station commander to be presented to some of the pilots – the oldest, the longest serving, the one with the most flying hours, the one with the most children, etc. Every time the CO looked at me and I pointed out one of the NCOs and even myself. Surrounded by twelve NCOs, His Majesty turned around, looked at one of the generals and said, 'Dear general, I though you told me this morning that there were no non-commissioned officers flying the F-104!'

***(Below)* Colonel Paul Dewulf, King Baudouin and Lt Col Georges Castermans. The Royal flight was a success and the King was presented with a scale model of the F-104 by SLt Roger Van Thielen, the youngest pilot on the squadron. Just thirteen days later, on 19 June 1969, FC-09, the King's Starfighter, was lost after Cdt Henri Loots accidentally ejected and ADC Leo Mommens had to eject also after control of aircraft was lost. Both occupants were severely injured. FC-01 was last used by 10 Wing on 30 March 1980. It was finally SOC in January 1987 and sold to Radcomm Enterprise who shipped the TF-104G to Taiwan.** via Jan Govaerts

## *Try to Beat the System*

The day that began so wonderfully well, was going to end with a tragedy. The same afternoon the weather cleared and Beavechain was going to participate in a fly-by over Brussels to commemorate the 25th anniversary of the 6 June 1944 D-Day invasion. *349ème* and *350ème* put up twelve Starfighters with two spares. One of the pilots was Major Wally D'Haese, visiting Staff pilot 1W, formerly of *349ème*. His aircraft was started when Wally experienced some trouble with his electronic

BLu **ground technician checks the 20mm cannon and surfaces of FX-51 during an inspection. Note the SUU dispenser on the aircraft centreline. FX-51 was TOC at Gosselies and issued to** 23ème/10W **on 14 July 1964. Its anti-ice ducts detached in flight on 24 January 1973 but Capt R. Van Thielen was unhurt. FX-51 transferred to** 31ème/10W **on 1 July 1982. Struck off charge in January 1987, it was sold to Radcomm Enterprise. Stripped of all useful parts in 1989, it was shipped to the USA on 20 June 1989 and bought for $14,000 by an unknown buyer on 20 May 1990 at the Santa Monica Museum of Flying auction. Preserved by Warren Sessler, Inc. in June 1990, it was sold two years later to the Flying Tigers Warbird Museum at Kissimmee, Florida. FX-51 is now preserved at Kissimmee as '60813/FG-813'.** via Peter Loncke

equipment. There was little time left before the order to taxi, so he called the leader and said that he was going to take one of the spares.

After the show over Brussels, Georges Castermans, the Wing Commander Flying, made a fly-by over the base with his wingmen at 2,500ft at 450kt. Overhead the base the unexpected happened. During the fly-by the aircraft encountered some turbulence and in Wally's aircraft (FX-55), the left undercarriage came out, ripping off the left flap and part of the wing. (In these early years of the F-104, the undercarriage was activated by hydraulic pressure and not locked up mechanically.) Miraculously, Wally was able to control his crippled aircraft and master it at a lower speed. Lots of pilots in the air gave him good advice over the radio. It was then decided to make Wally fly to the less populated area of Florennes and eject. One thing seemed to be overlooked. No-one told Wally to climb to a higher altitude. He maintained 2,500ft. After Beauvechain, two F-104s remained with him. One was piloted by André Desmittere and the other by André Tribel, his wingmen in the formation. Suddenly, we heard them cry out, 'Bail Out, Bail Out!' Wally had ejected without telling his wingmen. Things went so fast. They noticed the aircraft diving down and never saw the seat fire.

Airmen at Florennes started to search the crash area and finally found the pilot with his parachute unopened. When he had changed from his original aircraft to the spare Wally must have forgotten to connect his parachute lanyard, which in the case of a bail-out pulls the ripcord automatically when the pilot is kicked out of the seat. Highlighted in the Pilot's Notes under 'bail-out', it says 'Try to beat the system....'

## *Thirteen Days Later*

Jan Govaerts recalls:

Thirteen days later, on 19 June 1969, FC-09 took off again in the hands of a student pilot, 1Lt Henri Loots in the front seat, and instructor ADC Leo Mommens in the back seat. The mission was the same as 6 June – take-off on full afterburner, and accelerate to Mach .9 to initiate the climb. It was a very impressive manoeuvre in the Starfighter. First you had this terrific increase in speed and then the pull-up. It was like putting the F-104 on its tail. Pulling back on the stick had to be done with a smooth but continuous jerk. At briefing we told the students never to check forward again at this speed. In FC-09, Loots did, and the Starfighter started porpoising – a violent manoeuvre around the transversal axis which never seems to end. This movement is really scary with the nose going up and down the horizon. To stop it, you have to bring the centre of gravity forward by reducing the power and selecting speed brakes out, which is what the instructor did, after yelling at the student – 'I have it!'

Loots found himself pinned to the cockpit roof, then slammed back into his seat again! On releasing the controls he grabbed for something and had the D-ring of the ejection seat in his hand. Going up once again, the seat fired! Leo saw the flash of the rocket seat and some green objects hurtling towards his face, so he moved his hands to protect his eyes. It was not necessary as he had his helmet visor down, but this was a normal reaction. In his mind he went over things. What was the damage done when the front seat fired? Was there going to be a fire? Was the engine going to keep running smoothly? Did the engine injest any objects? Too many questions. There was only one answer – bail-out!

Both pilots ejected safely with only minor injuries. Leo Lambermont and I had watched the take-off of FC-09 and we saw the climb followed by two white parachutes blossoming out. The whole thing took a couple of seconds but when Leo Mommens told the story it took him an hour! Remarkably, the location where Henri Loots came down – at Mont St Guibert –was the same place where on 13 March 1956 he had crashed his Meteor NF11! It was during a night mission and his two engines both flamed out after water in the Kerosene had frozen up his fuel filters.

## *Fast Movers and Shakers*

Jan Govaerts recalls:

The F-104 was not an ideal 'dog-fighter'. Moreover it was a 'hit-and-run' fighter, which was due to its tremendous climbing speed and ability to accelerate to whatever speed was needed. This does not mean that as a fighter pilot you were unable to defend yourself against an aggressor. 'Air Combat manoeuvring' held no secrets for us in 1 Wing at Beauvechain, but there were limits. One of these limitations was the ultimate angle of attack where the aircraft is no longer able to respond and flips over in the 'pitch-up' attitude, followed by a difficult-to-control spin. The book even said: 'A spin revolution will result in a loss of about 1,800 to 2,000ft with each revolution taking five to six seconds and producing rate of descent of approximately 18,000ft per minute. The aircraft should be abandoned if rotation has not stopped by 15,000ft above ground level!'

An ingenious system prevented the F-104 from going into pitch-up. At a certain angle of attack the stick started 'shaking', warning the pilot that he was approaching a critical condition. This 'shaking' started at high angles in level flight and also in accelerated stall conditions, i.e.

**FX-84 was TOC at Gosselies and issued to** 349ème/1W **on 25 February 1966. It suffered a forced landing at Leeuwarden, Netherlands, on 18 August 1966 after a bullet destroyed the tube assembly during gunnery practice. Then, at Tanagra, Greece, on 6 November 1972 it suffered a partial undercarriage collapse during landing. Cdt D. Loriers, the pilot, was unhurt. FX-84 was withdrawn from use and stored on 10 December 1981, being SOC in January 1987. Radcomm Enterprise bought the aircraft and stripped it of all useful parts before shipping it to the USA on 20 June 1989. It arrived at Mineral Wells Municipal Airport, Texas, in 1989. By May 1990 it was at Mojave, and was subsequently registered N104PJ.** BLu

**Three Starfighters of** 350ème/1W **peeling to port. Nearest aircraft is FX-78 with FX-89 behind. FX-89 was withdrawn from use and stored on 14 April 1981 and SOC in January 1987, being bought by Radcomm Enterprise, who stripped it of all useful parts and stored it on behalf of the Royal Army Museum. FX-78 was TOC at Gosselies and issued to** 31ème/10W **on 6 October 1964. On 11 August 1969 FX-78 hit trees landing at Beauvechain after a night mission. SLt Robert Van Winckel, the pilot, was unhurt. This Starfighter suffered some other mishaps during its career before it was withdrawn from use and stored on 18 May 1983. FX-78 was SOC in January 1987 and sold to Radcomm Enterprise, who stripped it of all useful parts and transported it to Beauvechain to be used for ABDR training. FX-78 was assigned to the Royal Army Museum in September 1995.** *BLu*

**F-104G FX-32 of** 31ème/10W **at Kleine Brogel. This Starfighter was TOC at Gosselies on 21 February 1964 and issued to** 349ème/1W**. It suffered an in-flight accident on 18 June 1964 when the infrared glass broke. Capt Jack Lehardy, the pilot, was unhurt. FX-32 was acquired by the** Türk Hava Kuvvetleri **(THK, Turkish Air Force) in May 1983 and coded '069' (later 4-069).** Peter Loncke dog-fights, as well! If the pilot disregarded this 'shaking', seconds late the 'kicker' fired, pushing the stick forward with a jerk. On their first solo the F-104 pilots had to get acquainted with this 'shaker' and 'kicker'. There was an unwritten law that pilots had to take off with the 'Auto Pitch Control Switch' in the 'off' position to avoid inadvertent 'kicker' on take-off. Once the gear was up and the F-104 safely climbing away, we called the wingman to check his 'APC'.

In normal flying without flaps, and on take-off with flaps the pilot could have a 'shaker' and a 'kicker'. With the flaps in 'landing position' there was only a 'shaker' and no 'kicker'! On two occasions the Belgian Air Force lost a Starfighter because the pilots engaged in a dog-fight with a Mirage with their flaps in the 'landing position' (to turn steeper). Both their aircraft went into 'pitch-up'. There was no 'kicker' to warn them, and they had to eject!'

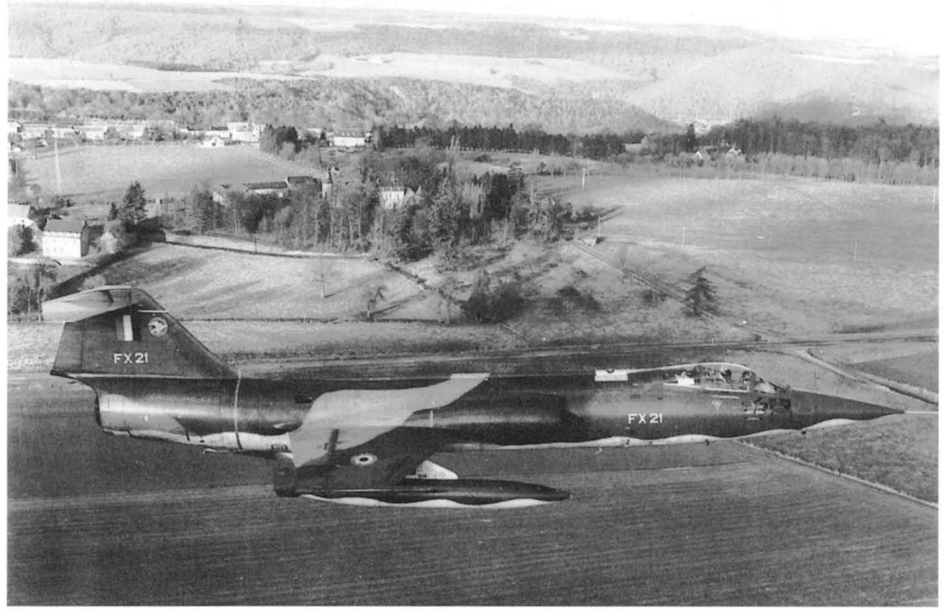
## *Still Alive and Kicking: the loss of FX-01*

'Pitch-up resulted in the loss of three Belgian Air Force Starfighters. The first occasion was on 14 December 1966, when Maj Emmanuel Kennes, CO, *350ème*, was killed after his Starfighter (FX-16) went into a pitch-up on the break. On 20 April 1967 SLt Pierre Rassart of *349ème* ejected safely in a pitch-up after experiencing problems in a dogfight with a Mirage V.

The third and last Belgian Starfighter lost as a result of 'pitch-up' occurred on 26 January 1971 when Capt Luc Declerck experienced pitch-up in FX-01 and had to eject using his C-2 seat. Declerck was to recall the events of this day some twenty-seven years later in a conversation with Jan Govaerts:

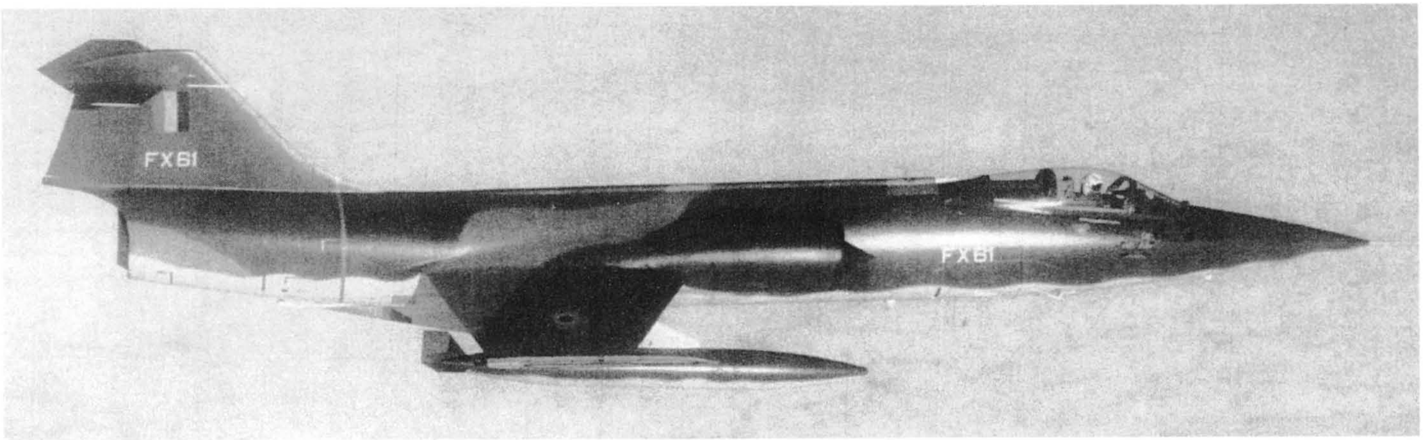
> Some details of the mission I flew for *350ème* that day are not very clear any more but essentially it is still there as if it happened yesterday. The pain in my back, which is unbearable at times, is more than an aid to memory. I took off on a 'freelance' interception mission under radar control. After two successful intercepts, the job was done. I set course to home base at 32,000ft, when all of a sudden, I noticed an acceptable target some 2,000–3,000ft below. I had an ideal attack position and I decided to have a go! Seconds later, I was engaged in a dogfight. During a steep turn to the right with a bank of 60 degrees with manoeuvring flaps and the engine at the gate with full afterburner, the nose of my Starfighter pointed steeply above the horizon. It looked like a spin but I knew better; this was 'pitch-up'!
>
> Since the aircraft moved to the right, I pushed left full rudder and moved the stick fully forward. I selected 'flaps up' and shortly after, went back to 'take-off flaps'. At this time the instruments were impossible to read. Everything was shaking very badly! The 15,000ft of the Dash-1 flashed through my mind and I remember having seen 16,000ft on the altimeter. My position was above the Ardennes. Good heavens, there is no more flying. I grabbed the D-ring between my feet and pulled.

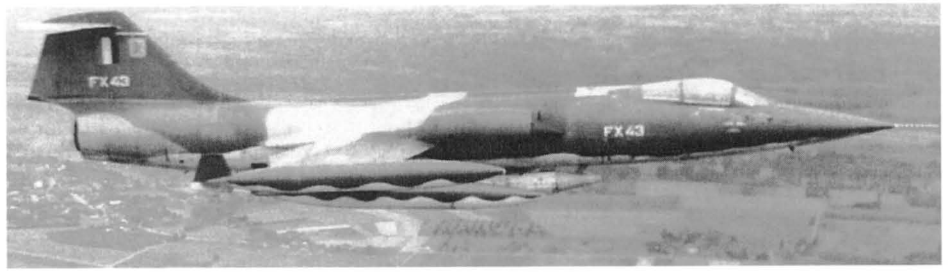
**F-104G FX-34 at Kleine Brogel. This Starfighter was TOC at Gosselies on 9 March 1964 and was issued to** 349ème/1W. **It suffered a heavy 'nose-wheel shimmy' on take-off on 10 December 1964 and the pilot, Adj E. Swanepoel aborted and engaged the barrier. In 1973 FX-34 was displayed in front of the Officers Mess at Domaine La Chise (Beauvechain) before the aircraft was flown to Turkey on 22 April 1982 where it was recoded 071 in the** Türk Hava Kuvvetleri (THK, **Turkish Air Force).** Peter Loncke



***(Right)*** **F-104G FX-21 of 1 Wing, Bevekom. FX-21 was TOC at Gosselies on 14 November 1963 and was issued to** 349ème. **Like many Starfighters, FX-21 suffered mishaps during its career. At Beauvechain on 18 January 1964 its canopy was blown off by jet blast. Pilot, Cdt H. d'Hoop, was unhurt. At Beauvechain on 13 November 1967 ADC P. Weymans hit the runway lights on take-off for night flight but was unhurt. FX-21 was withdrawn from use on 13 February 1980 and used as an instructional airframe at Saffraanberg. On 28 October 1993 FX-21 was repainted as FX-23 and put on display at Evere-Zuid.** Peter Loncke

**Four F-104Gs of** 23ème **overflying Kleine Brogel. Nearest aircraft is FX-96 and behind are FX-33, FX-13 and FX-19. FX-96 was TOC at Gosselies on 23 March 1965 and issued to** 1 Wing **on 23 March 1967. Transferred to** 31ème/10W **on 1 July 1982, a year later, on 7 October 1983, it was withdrawn from use and preserved at Kleine Brogel before being SOC in January 1987 and being sold to Radcomm Enterprise. Stripped of all useful parts, it was used for ABDR training at Kleine Brogel. FX-33 was TOC at Gosselies on 27 February 1964 and was issued to** 350ème/1W. **Acquired by Turkey on 29 January 1981, it was recoded '070'. FX-19 was TOC at Gosselies on 30 September 1963 and was issued to** 350ème/1W. **This aircraft was acquired by the** Türk Hava Kuvvetleri (THK, **Turkish Air Force) on 16 July 1982 and recoded '044' (later 4-044). 4-044 crashed at Balikesir in 1989.** Peter Loncke





***(Above)*** **Jan Govaerts flying F-104G FX-61 photographed by a USAFE RF-4 Phantom at 32,000ft (9,750m). FX-61 was withdrawn from use on 26 September 1983 and preserved at** 23ème/IOW **at Kleine Brogel. After being SOC in January 1987 it was bought by Radcomm Enterprise and stripped of all useful parts before being used as an ABDR airframe at Kleine Brogel. In December 1989 FX-61 was acquired by the 'Tiger Air Force Museum' at Peer.** Jan Govaerts

**F-104G FX-43 of 10 Wing Kleine Brogel with four fuel tanks and a BDU (Bomb Dispersal Unit) on the centreline. FX-43 was TOC at Gosselies and issued to** 23ème/10W **on 14 May 1964. It was lost at Corbais at 0900hr on 26 January 1973 following a power loss on take-off due to fuel problems. Cdt Paul Naime, Wing Ops, ejected successfully.** Jan Govaerts

The ring fired two initiators. One ejected the canopy, the other started pre-ejection functions. In three tenths of a second this happened: Metal stirrups pulled Declerck's feet close to his body and held them until time of man–seat separation. Knee guards rotated into position to prevent his legs spreading and to counteract the effects of airloads. Arm support webbing flipped up and prevented outward movement of his arms. Moving up the rails, the seat hit a striker, and – one second later – Declerck's lap belt was released, foot retention cables cut, and the pilot seat reel operated.

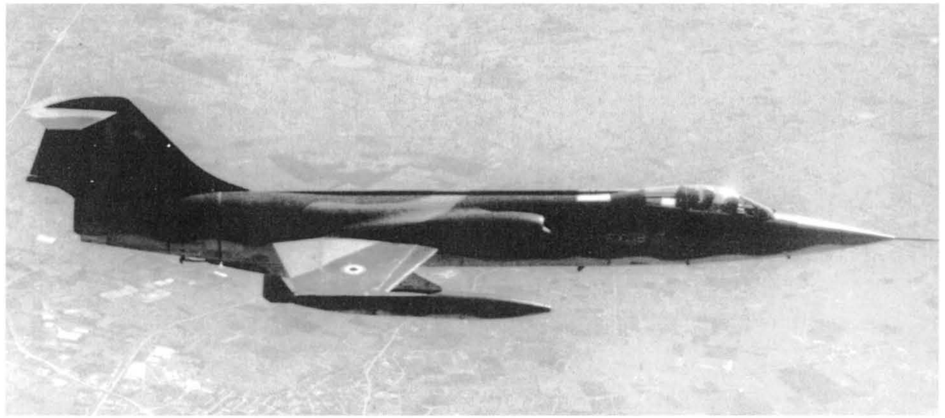
Forcible separation was actuated pyrotechnically by a windup reel behind the head rest. Sequenced with the lap belt release, the webbing was drawn taut between the head rest and the lip in two tenths of a second 'pushing' Luc Declerck out and away from the seat one second after ejection.

Luc Declerck continues:

> Soon after I regained consciousness and saw lots of things twirling around me. I raised my eyes heavenward and saw, a few feet above, my ejection seat – my guardian angel, my angel in need.

ADC Jan Govaerts of 350ème. Govaerts joined the Force Aérienne Belge (FAé)/Belgische Luchtmacht (BLu) in July 1950 and went on to fly the T-6 Harvard and T-28 Trojan in the USA, the Spitfire IX and XIV and the Meteor T7 and Mk.4, as well as the CF-100 Canuck at Cold Lake, Canada. On 1 March 1961 he became an instructor at the Advanced Training School at Brustem on the CM-170 Fouga Magister. On 10 January 1965 Jan Govaerts began the conversion course on the Starfighter at Waffenschule 10 at Jever, Germany, and then became a member of 350ème and an instructor in the Flight TF, a post he held until 29 June 1977. His total time on Starfighters amounts to 2,511.15hr and his total time on Air Force aircraft of all types was 6,295.5 (including 5,789hr on jets). He lives in active retirement in Belgium where he teaches gliding to air cadets. Jan Govaerts

*(Right)* Flight TF on 22 September 1971. L-R: ADC Jan Govaerts; André Mignon, who as a member of 349ème was one of the first Belgian pilots chosen for F-16 training; Gommaire Van Beneden, later a member of 349ème on F-16s who changed squadrons and joined 350ème where he successfully ejected on 19 August 1986 after his F-16 (FA-42) caught fire. He was promoted Lt Col and was safety pilot of 1 Wing when he had to eject once again, this time in F-16B FB-06, on 13 July 1989!; Jean-Marie Toussaint, who became an F-16 instructor until the end of his career, and the first Belgian pilot to achieve 3,000hr on the Fighting Falcon; Michel Top, later Wg Cdr, flying at Brustem AB; Leo Lambermont, instructor. Jan Govaerts



*(Below)* F-104G FX-39 at 30,000ft (9,140m) photographed by a Mirage BR (Reconnaissance aircraft of 42ème. FX-39 was TOC at Gosselies and issued to 349ème/1W on 11 May 1964. It was finally withdrawn from use on 21 December 1979 and put to use as an instructional airframe at the Royal Technical School at Saffraanberg. Jan Govaerts

This was it. Free fall! Was this possible? Should it be like this? I moved both my hands towards my back to touch the parachute. Good heavens – nothing! It gave me a nauseating feeling. So this was it. No parachute. My career was going to end. So where was the film of my past life? Where was it? Everyone talks about it. Why couldn't I see it?

Beat the system. Oh yes, another thing in the Dash-1 marked in bold face. I gave a jerk on the D-ring of the parachute. There was a jolt and the parachute blossomed out above my head. I was going to survive!

Was there anything else to do? The morning weather forecast gave gusts in the area of up to 35mph so I though I had better keep my bone dome on, but I decided to get rid of my oxygen mask. Below 15,000ft I didn't need oxygen any longer. Of course then I realised why I need not have worried. The parachute would have opened automatically once 15,000ft altitude was reached! How could I have been that stupid? I decided to keep my spurs[21] on and would drop them when closer to the ground, but the survival pack had to be activated now. I pulled the handle and saw the dinghy blossom up below me! Wrong again! The whole pack dropped away out of sight. Did I make a mistake again?

The ground came up very near now. Spurs away. I had the impression of falling horizontally. It was either the slope of the terrain or the wind that gave me this idea? Jesus! I missed the roof of a farmhouse by inches and I had to avoid a barbed wire fence. Bringing my feet up, I cleared this last obstacle. I should not have done this because I hit the ground very hard, so hard that two visors of my helmet slid down. I was so nervous that I had difficulty opening the quick releases of the parachute harness and the wind was so strong that it dragged me away from the spot.

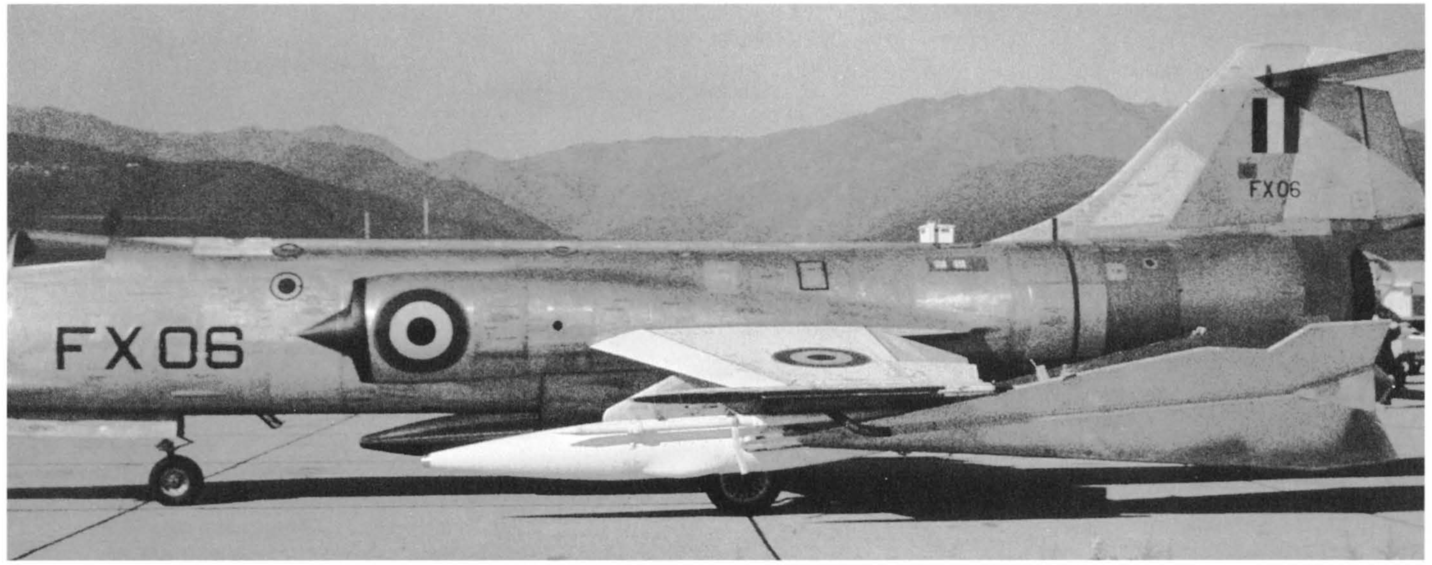
Once the releases were open I bundled up the parachute. It was all over now. I finally felt safe. The farmhouse I had missed by inches was a haven of refuge and the landlady offered me a much appreciated drink. It took me seconds to phone the authorities and I hoped that my aircraft had not caused anyone any harm when it crashed. Good news, it had crashed in open country and the wreckage was spread over a good square mile. People even found my spurs and my survival pack. Later that evening I was back in *350ème*, hurt, but in high spirits! My back injury is another story!

## *'The Good Old J79'*

Jan Govaerts pays tribute to the General Electric engine that powered the Starfighter:

The good old J79 was a marvellous engine, powering the Starfighter like a rocket. With the

ADC Jan Govaerts (left) receives congratulations from Lt Col Gerard Debackere, 1 Wing commander, Maj Paul Debeurm, Chief Technical Officer, and Col René Soufnonguel, Beauvechain station commander, after becoming the first Belgian Starfighter pilot to log 2,000hr (in FC-08) on 24 February 1975. Jan Govaerts



F-104G FX-06, which was TOC at Gosselies on 8 July 1963 and issued to 350ème/1W, at Solenzara, Corsica, with air-to-air gunnery practice firing dart attached, in 1965. Flown by Maj R. Blanchart, FX-06 collided with a dart at Solenzara on 14 October 1965 and on 28 September 1970, Maj J. Defrays did the same. On 16 February 1971 ear defenders were sucked into the engine at Beauvechain when it was being piloted by ADC H. Devos. None of these pilots was injured in these three incidents. Jan Govaerts

**F-104G FX-06 at Solenzara, Corsica, for air-to-ground firing exercises on 4 October 1976. FX-06 was lost at Vlieland-range (Netherlands) a year later, on 6 April 1977 when Capt Fritz Hartmann of** 31ème/10W **hit a dune after pulling up out of bomb run and was killed.** Peter Loncke

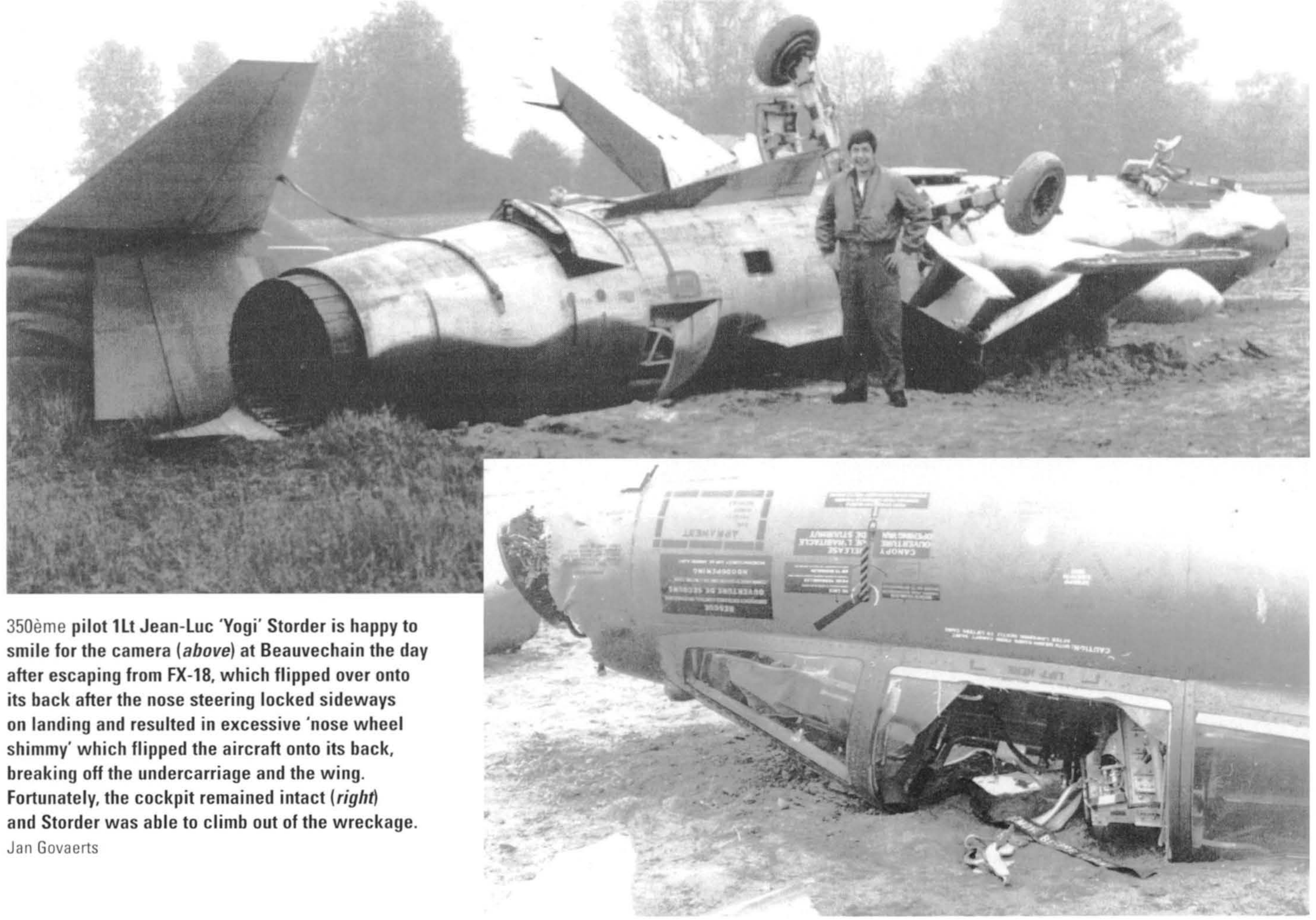
afterburner going and with very little fuel remaining, you could really put the 104 on its tail and zoom it up. As far as I know in the Belgian Air Force, we never experienced an airborne engine failure. To take off we had to go full forward on the afterburner and this is where the fun started. There was only one way to light the afterburner and that was the 'good way'! With the pilot burner blazing in the exhaust the afterburner had to light and give you the 'kick in the ass', if you set the throttle position correctly! If not, the nozzle opened and instead of having thrust, it gave you the impression of slowing down! Sometimes, it confused pilots so much that they aborted take-off. Sometimes they returned and said, 'This aircraft does not go into the afterburning range properly.'

So, one day, in good old 'three-fifty squadron', a pilot, on his return from a mission, noted in the Form 700 that his F-104 had difficulty going into afterburner. Short of aircraft that day, the CO, Mj Georges Castermans took note of this, looked round and told ADC Guy Famenne to take the aircraft to the runway and perform an afterburner check. Guy was the youngest recruit in the smaldeel, with very little experience on the F-104!

The aircraft, FX-18, was not serviced and had some 1,200lb of fuel remaining. Guy went to the hangar, picked up a test sheet and climbed into the aircraft. He did not strap in, started the aircraft, taxied out, and had the safety pins of the launchers removed. After the control tower gave him clearance, Guy was told to go ahead with his test. He lined up on Runway 04 left, ran up the engine twice, taking note of the instrument readings, and opened up the engine again. He lit the afterburner and went full afterburner (without any problems), released the brakes, and let go!

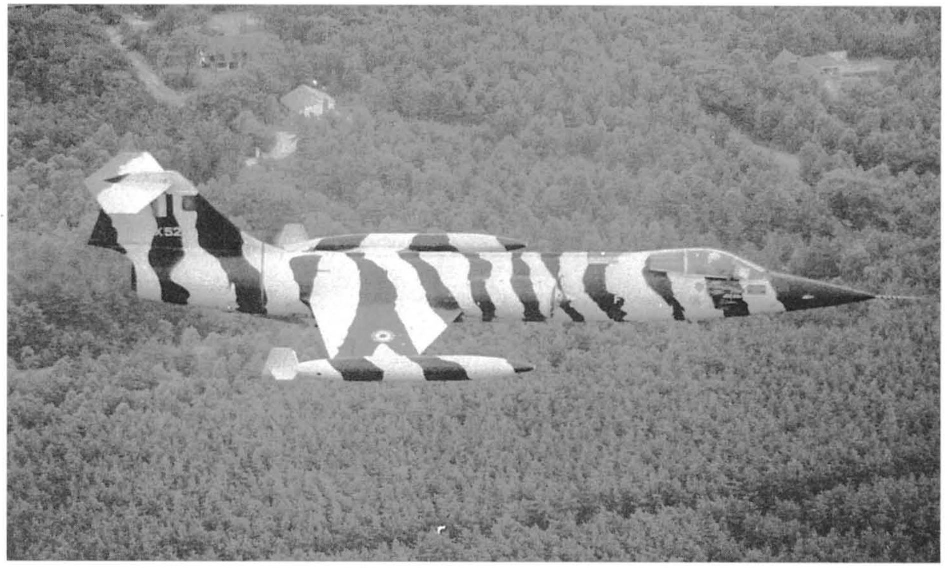
Noting down the readings was a matter of seconds and suddenly, he had a strange feeling. 'Boy, this aircraft was screaming down the runway and by God, he noted 180 knots on the airspeed indicator!' This was flying speed! Guy pulled the throttle back into full idle, got hold of the nosewheel steering and moved his hand forward to pull the drag chute. 'Blast! This aircraft was not serviced and there was no chute!

OK, no sweat. He could always take the barrier, but once again a shiver went down Guy's spine. He had not strapped in and taking this barrier at high speed without straps would have killed him! So guy did the only thing that was left to him. He hit the brakes and hit them continuously. Luckily for him there was sufficient wind to help him aerodynamically and he was able to turn off the runway on the last intersection. Two aircraft were at that point on standby to line up for take-off on 22 right, and one of the pilots told Guy that smoke was curling up from his wheels! Guy acknowledged and kept taxiing. He came to a full stop right in front of the dispersal to have his launcher pins put in, when his tyres blew up! His squadron commander was a very interested bystander!



350ème **pilot 1Lt Jean-Luc 'Yogi' Storder is happy to smile for the camera (*above*) at Beauvechain the day after escaping from FX-18, which flipped over onto its back after the nose steering locked sideways on landing and resulted in excessive 'nose wheel shimmy' which flipped the aircraft onto its back, breaking off the undercarriage and the wing. Fortunately, the cockpit remained intact (*right*) and Storder was able to climb out of the wreckage.**
Jan Govaerts

**At Beauvechain on 14 December 1979 SLt L. Vanlandeghem of** 1 Wing **suffered a loss of control on take-off in FX-79 following oil loss. FX-79 was declared Cat.4 and SOC on 3 October 1980, later being sold to a Belgian scrap dealer. In the mid-1980s the F-140G was bought by Maurice de Groote of Beervelde, who displayed the Starfighter on top of some containers to publicize his company.** Jan Govaerts



***(Below)* F-104G FX-52 of** 31ème/10W**, in Tiger colours at Kleine Brogel, on 10 May 1980. This aircraft was originally TOC at Gosselies and issued to** 23ème/10W **on 8 June 1964. It joined** 31ème **on 9 August 1973 and received its 'Tiger' colour scheme in June 1978 for that year's Tiger-Meet' at Kleine Brogel.**
Jan Govaerts

**FX-52 taxies in at Kleine Brogel on 10 May 1980. This aircraft was damaged in a mid-air collision with FX-11, piloted by Maj Theodoor Theeuwen of** 31ème/10W**, at Neffe (Dinant) on 10 November 1981. The pilot of FX-52, 1Lt Yvan Janssens, managed a perfect emergency landing at Kleine Brogel. FX-11 crashed near the Dinant Dominican Abbey. Maj Theeuwen was found dead nearby after his chute became entangled following ejection.** Peter Loncke

**Peter Loncke loads the 20mm cannon of F-104G FX-85 at Solzanara, Corsica, in 1980. This Starfighter was TOC at Gosselies and issued to** 1 Wing **on 7 July 1966. It had suffered a Cat.4 at Beauvechain on 12 April 1967 when the undercarriage collapsed. Cdt Jack Lehardy emerged unhurt.** Peter Loncke

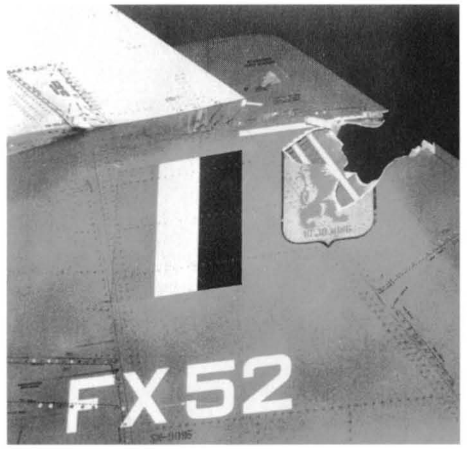
**Peter Loncke loading a 2.75in rocket on F-104G FX-85 at Solzanara, Corsica, in 1980. FX-85 was withdrawn from use and stored on 27 February 1981 before being SOC in January 1987 and being bought by Radcomm Enterprise. Stripped of all useful parts, FX-85 was transported to Florennes for ABDR on 15 July 1991. It was stored on behalf of the Royal Army Museum in September 1995.** Peter Loncke

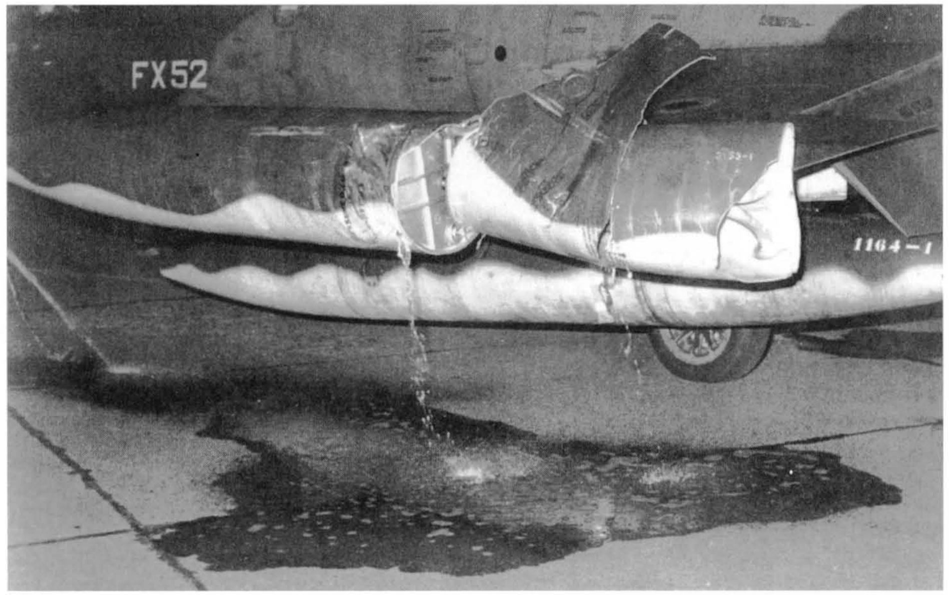
This was not the end of F-104G FX-18's troubles, as Jan Govaerts explains:

> The F-104 was really not an aircraft to crash land, so no-one ever tried. On landing, the Starfighter's nose had to be put down gently on the runway at the correct speed and nosewheel steering had to be engaged so that no shimmy was experienced. Pilots therefore had to avoid stalling the nose. Now, since the tail section of the Starfighter was a good target for crosswinds, the steering was very necessary to keep a straight line. Releasing the control in order to remove the shaking nose was the best solution. Another solution was to release the drag chute in order to lift the load on the nose but in doing this the terrible crosswind would take over and force the aircraft to one side of the runway. When the speed slows down the rudder control gets less and less effective, so that the pilot engaged the nosewheel steering again with the same result, very heavy nosewheel steering.
>
> On 23 May 1978 1Lt Jean-Luc Storder in FX-18 experienced a very heavy nosewheel shimmy on landing. Part of the undercarriage broke away and the Starfighter turned over onto its back, trapping him in his cockpit. The firecrew were able to release him only after breaking the canopy with a crowbar. Jean-Luc managed to crawl out without injury. He was lucky. He must have looked death in the face and had a narrow escape!

**Last flight of the Beauvechain Starfighters, 10 April 1981.** 349ème **was already flying F-16s, and a few** 350ème **pilots were left to fly the remaining Starfighters. Capt Philippe Callandt led the formation in FX-80. This aircraft had been TOC at Gosselies and issued to** 31ème/10W **on 19 October 1964. 1Lt Bart Boeykens flew FX-84. 1Lt Mark Bongartz flew FX-57. This Starfighter had been TOC at Gosselies on 15 May 1964. 1Lt Roger Uytterhaeghen piloted FX-72. This Starfighter was TOC at Gosselies and issued to** 10 Wing **on 3 September 1964 before joining** 1 Wing **on 7 December 1970. FX-74 with 1Lt Luc Landeghem went u/s and never took off. (This aircraft was TOC at Gosselies and issued to** 31ème/10W **on 9 October 1964. It joined** 350ème/1W **on 6 March 1969.) FX-80, FX-84, FX-57, FX-72, and FX-74 were all SOC in January 1987 and sold to Radcomm Enterprise, who transferred them to Taiwan in October 1990.** Jan Govaerts

On 10 April 1981 the last official flight of the Beauvechain Starfighters of *350ème* took place when Capt Philippe Callandt, 1Lt Bart Boeykens, 1Lt Mark Bongartz and 1Lt Luc Van Landeghem flew the mission. A few months later, on 30 November, the first Belgian F-16 landed at Kleine Brogel.




**On 10 November 1981 the last accident involving a** BLu **Starfighter took place when FX-11 and FX-52 collided in mid-air. Maj Theodoor Theeuwen of** 31ème/10W**, the pilot of FX-11, was killed. The pilot of FX-52, 1Lt Yvan Janssens, managed a perfect emergency landing at Kleine Brogel. FX-52 was repaired using the tail section of FX-86, which had been displayed as the gate guardian at Kleine Brogel since 1 July 1981 after suffering a bird strike in the engine over Diepholz on 26 June. FX-52 was finally withdrawn from use and stored on 24 June 1983. It was SOC in January 1987 and sold to Radcomm Enterprise, who stripped it of all useful parts before the Starfighter was transferred to the Royal Army Museum on 15 July 1991.** Jan Govaerts

On 21 October 1982 ADC John Lemmens became the first and only Belgian Air Force pilot to log 3,000hr on the Starfighter. The last flight of a Belgian Starfighter took place on 26 September 1983 when Capt Aerts (in FX-99) and ADC John Lemmens and 1Lt Steens (in FC-11) landed at Koksijde. Lemmens finished with the most flying time on the F-104, with 3,007hr. Next was Cdt Fernand Dasseville, with 2,757hr. I was third highest with 2,522 hours. Ten of the NCOs in Beauvechain were instructors on the F-104 and what is more, in the F-16 era, two NCOs of *10 Wing Chasseurs-Bombardiers/10 Wing Jager-Bommenwerpers* became instructors on the Fighting Falcon at Kleine Brogel. Such was the situation in the early sixties. Later, in the seventies, considering the experience we had on the Starfighter, the Belgian Air Force accepted young pilots with barely 300 hours' flying total.

The final tribute to the Starfighter goes to Jan Govaerts:

> The F-104 used to be the hottest fighter for so many years and she could truly be flown high, wide and handsome. Some of her shortcomings were doubtless the result of inexperience on the part of those who designed and tested her, and the political pressure that was exerted in the early years. In the hands of a capable pilot the Starfighter could chalk up respectable gunnery scores on towed targets. It was a good, stable, weapons platform and handled well under instrument flying conditions. Accidents happened, but these never made us professionals dislike the Starfighter.
>
> One thing is certain, many genuine tears were shed into many a beer when the old gal's wheels were chocked and her big turbine wound down for the last time.

**_Force Aérienne Belge_ (_FAé_)/_Belgische Luchtmacht_ (_BLu_) Starfighter Inventory (SABCA-Built F-104Gs)**

| *C/n* | *Serial* | *Notes* | *C/n* | *Serial* | *Notes* |
|---|---|---|---|---|---|
| 9016 | FX-01 | Officially presented to press as first European- (and SABCA) built F-104G.Astonishing presentation by test pilot Bernard Neefs. TOC at Gosselies and issued to *350ème/1W* 14.2.63. Used as instructional airframe at Saffraanberg, 1966–3.68. To *IW* (liaison flight) 3.68–1.71. Cat.4 at Bitburg on 5.6.69 when main gear collapsed during taxing on bad taxi track. Pilot, Capt H. Vandegaer unhurt. Cat.3 at Beauvechain on 1.7.70 when it undershot the runway due to wrong landing technique. ADC J. Vanhaesendonck unhurt. Cat.5 at Capois-Leignon near Ciney at 10.30 hr on 26.1.71 resulting from 'pitch-up'. Capt Luc Declerck of *350ème/1W* ejected successfully. | 9017<br>9018 | FX-02<br>FX-03 | TOC at Gosselies 24.4.63 and issued to *350ème/1W* on 30.4.63 (flown by Cdt Georges Castermans). Last used by *31ème/10W* 1.7.82. SOC 20.6.83. To Royal Army Museum 15.7.91. To Evère in 1998 to be used as spare parts for FX-52 restoration.<br>TOC at Gosselies 3.4.63 and issued to *350ème/1W*. Cat.1 at Beauvechain: 5-fingers check. Crew chief fingers caught. Cdt Castermans, pilot, unhurt. Cat.4 at Beauvechain 27.3.75 caused by lightning strike. Pilot, Adj Bart Boeykens unhurt. Transferred to *31ème/10W* 6.6.78. Flown to Koksijde 3.11.81 for storage and withdrawn from use. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF. |

### *Force Aérienne Belge* (*FAé*)/*Belgische Luchtmacht* (*BLu*) Starfighter Inventory (SABCA-Built F-104Gs) *(continued)*

| *C/n* | *Serial* | *Notes* |
|---|---|---|
| 9019 | FX-04 | TOC at Gosselies 4.63. Flown to Beauvechain by Lt Col Steve Cailleau (Wing Commander) for official acceptance ceremony of first *1W* F-104G. To *350s/1W* 19.4.63. First official flight from Beauvechain by Maj Marcel Legrand (CO, *350ème*). Cat.2 at Beauvechain 12.11.65. Collision with unknown object on landing. Capt G. D'Hert unhurt. Cat.2 in flight 21.3.68 after accidental opening of landing gear door. Cdt L. Forgeur unhurt. Cat.5 at Kleine Brogel 13.7.76. Engine bay fire. Used as a/c loading training airframe at *10W*. SOC 3.1.77. To Beauvechain in August 1990 for gate guardian duty in front of the Officers Mess, replacing Spitfire SG-31. |
| 9020 | FX-05 | TOC at Gosselies 21.5.63 and issued to *350ème/1W*. To *349 ème/1W* 11.63. Cat.5 at Samèe-Dochamps 20.6.68 after power loss during a return flight from Bitburg to Beauvechain. Cdt Henri Vandegaer (Wing Ops) ejected successfully. |
| 9021 | FX-06 | TOC at Gosselies 8.7.63 and issued to *350ème/1W*. Cat.2 at Beauvechain 4.6.64. Severe nose wheel shimmy on landing. Capt E. Baestaens unhurt. Cat.2 at Solenzara Corsica, 14.10.65 following collision with practice firing dart. Maj René Blanchart unhurt. Cat.2 at Solenzara, 28.9.70 following collision with dart due to technical problem. Major J. Defrays unhurt. Cat.2 at Beauvechain 16.2.71, when ear defenders were sucked into engine. ADC H. Devos unhurt. Cat.5 at Vlieland-range (Netherlands) 6.4.77. Cpt Fritz Hartmann of *31ème/10W* hit a dune after pulling up out of bomb run and was killed. |
| 9022 | FX-07 | TOC at Gosselies 6.6.63 and issued to *350ème/1W*. Cat.2 during in-flight firing practice caused by double feed of gun, followed by in-side firing. ADC W. Van de Perre unhurt. Cat.2 at Beauvechain 3.11.72 caused by bird strike on take-off. 1LT R. Raes unhurt. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF. |
| 9023 | FX-08 | TOC at Gosselies and issued to *350ème/1W* 2.7.63. Cat.5 at Taviers 16.7.63. Disconnected bleed-air tube for flaps, blew hot air over fire-detection sensor which gave false fire-warning. Capt Georges Castermans ejected safely. |
| 9024 | FX-09 | TOC at Gosselies 12.8.63 and issued to *350ème/1W*. Cat.3 at Beauvechain. Collison with hook of target. ADC Jan Govaerts unhurt. Cat.2 at Solenzara, Corsica, 4.9.68. Barrier engagement after landing with heavy cross-wind. SLt A. Desmittere unhurt. Cat.5 at Solré-sur-Sambre 23.35 hrs 3.8.76. G-loc and crash. Capt Walter Vandenenden killed. |
| 9027 | FX-10 | TOC at Gosselies 8.7.63 and issued to *350ème/1W*. Cat.4 at Beauvechain, 11.4.67. Loss of main undercarriage wheel on landing due to maintenance error. SLt Pierre Rassart unhurt. Cat.2 at Beauvechain 18.11.77. Landed beside runway due to loss of control caused by abnormal use of engine. Pilot Capt J/C. Servais. To *349ème/1W* 10.4.80. Cat.2 at Solenzara, Corsica. Loss of flap. Pilot SLt Luc Van Landeghem. Flown to Koksijde 5.2.81 for storage and withdrawn from use. SOC January 1987 and sold to Radcomm Enterprise. To Taiwan AF. |
| 9028 | FX-11 | Flown to Le Bourget 6.6.63 by Bernard Neers for the XXV Salon, beating the Brussels to Paris speed record with a time of 9min 55sec at an average speed of 978.9mph (1,575km/h). TOC at Gosselies 2.8.63 and issued to *350ème/1W*. Cat.5 at Neffe (Dinant) 10.11.81 after a mid-air collision with FX-52. FX-11 crashed near the Dinant Dominican Abbey. Maj Theodoor Theeuwen, *31ème/10W*, found dead near Mobelco plant at Neffe after his ejection seat chute became entangled. |
| 9029 | FX-12 | TOC at Gosselies 12.8.63 and issued to *350ème/1W*. Cat.2 at Solenzara, Corsica, 12.4.79. Hit by ricochet during air-gunnery practice. Pilot Capt J.C. Servais. Flown from Beauvechain. to Brustem and withdrawn from use 8.11.79. Transported by road to Royal Army Museum 4.5.83. |
| 9032 | FX-13 | TOC at Gosselies 9.8.63 and issued to *350ème/1W*. Cat.2 at Helchteren 28.7.67. Hit by ricochet during gunnery training. Pilot Cdt A. Ronge. Used by 'Slivers' aerobatic team. Cat.2 at Beauvechain 17.7.75. Bird strike on landing. Pilot SLt J.M. Rase. Cat.5 at Mellet/Wayaux (Gosselies) 13.32 hrs 12.12.78. Flew into ground. Precise cause never determined. Capt Martial 'Stony' Vansteenkiste killed. |
| 9033 | FX-14 | TOC at Gosselies 15.10.63 and issued to *350ème/1W*. Cat.4 at Beauvechain 26.1.66. Broken bolt on runup. ADC Jan Govaerts unhurt. Cat.5 on take-off at Dion-le-Mont 20.7.70. Maj Guy Paulet killed. |
| 9034 | FX-15 | TOC at Gosselies 29.8.63 and issued to *350ème/1W*. Cat. 2 at Beauvechain 27.10.66. Collision with target. ADC Palmer Devliegher unhurt. Cat.2 at Beauvechain 14.7.70. Pylon racks jettisoned during taxi. SLt P. Vereecke unhurt. Cat.2 at Beauvechain 5.11.70. Fire in fuel tank on start up. Maj A. Willems unhurt. Withdrawn from use 27.4.83. Transported to Saffraanberg 4.5.83 and used as instructional airframe. Transported to Glons September 1996 for display. |
| 9038 | FX-16 | TOC at Gosselies 17.10.63 and issued to *349ème/1W*. Cat.2 in flight 15.7.64. Fuel leak. Adj H. Nuyens unhurt. Cat.5 at l'Ecluse 14.12.66. Pitch-up during circuit. Maj Emmanuel 'Manu' Kennes, CO *350ème/1W*, ejected unsuccessfully and was killed. |
| 9039 | FX-17 | TOC at Gosselies 16.9.63 and issued to *350ème/1W*. Transferred to Turkish Air Force as 9-039 16.7.83. |
| 9040 | FX-18 | TOC at Gosselies 13.9.63 and issued to *349ème/1W*. Cat.2 25.3.65 at Beauvechain. On take-off Cdt A. Richir retracted undercarriage too soon and hit runway. Cat.4 at Solenzara 23.9.70. Aircraft hit by ricohet during air–air gunnery practice. 1Lt Pierre Moulin unhurt. Cat.5 at Beauvechain 23.5.78. Nose steering locked sideways/excessive nose wheel shimmy on landing. Aircraft flipped onto its back. Undercarriage and wing broken off. 1Lt Jean-Luc Storder injured. |
| 9041 | FX-19 | TOC at Gosselies 30.9.63 and issued to *350ème/1W*. Cat.2 at Beauvechain 13.2.67. Canopy unlocked on take-off. Adj W. Cowez unhurt. To Turkey 16.7.82. as 044 (later 4-044). Crashed and w/o at Balikesir in 1989. |
| 9045 | FX-20 | TOC at Gosselies 30.10.63 and issued to *349ème/1W*. Cat.3 at Solenzara 9.8.68. Maintenance error. No test of electrical drop auto. ADC J. Elen unhurt. Cat.2 in flight 12.7.78. Loss of filler cap on tip tank. Pilot Cpt J.G. Moureau. To Turkey via Rimini 17.5.83 as 045 (later 9-045, 4-045). |
| 9046 | FX-21 | TOC at Gosselies 14.11.63 and issued to *349ème/1W*. Cat.2 at Beauvechain 18.1.64. Canopy blown off by blast. Cdt H. d'Hoop unhurt. Cat.2 at Beauvechain 13.11.67. Hit runway lights on take-off for night flight. ADC P. Weymans unhurt. Withdrawn from use 13.2.80. Used as instructional airframe at Saffraanberg before being put on display as 'FX-23' at Evere-Zuid on 28.10.93. |
| 9050 | FX-22 | TOC at Gosselies 14.11.63 and issued to *350ème/1W*. To Turkey 7.12.82. as 050 (later 4-050). |
| 9051 | FX-23 | TOC at Gosselies 31.12.63 and issued to *349ème/1W*. To Turkey 17.5.83 via Rimini as 051 (later 4-051, 9-023 and 4-023). Dumped at Balikesir in 1989. |
| 9052 | FX-24 | TOC at Gosselies 28.2.64 and issued to *349ème/1W*. Cat.1 in flight 18.6.64. Infra-red glass broken. Adj E. Swanepeol unhurt. On 19.6.75 on taxiing out, the jet blast of FX-24 blew open the canopy of parked FX-98. Capt Fritz Hartmann unhurt. To Turkey 7.12.82 as 052. |
| 9056 | FX-25 | TOC at Gosselies 12.3.64 and issued to *349ème/1W*. Cat.5 at Sint-Jan-Geest/Zetrud-Lumay 13.1.77. Crashed on approach to Beauvechain due to stick-kicker lock. Capt J. Cammaerts, *350ème/1W*, ejected successfully but was badly injured. |
| 9057 | FX-26 | TOC at Gosselies 21.2.64 and issued to *349ème/1W*. To Turkey 17.5.83 via Rimini as 057 (later 4-057, 9-057 and 4-057). |
| 9058 | FX-27 (a) | Cat.5 at Sart-Dames-Avelines 21.11.63. Flame-out during pre-delivery test flight. SABCA test-pilot Bernard Neefs ejected safely. |
| 9082 | FX-27 (b) | TOC at Gosselies 26.6.64 and issued to *349ème/1W*. Cat.3 at Court St Etienne, 9.7.64 (lightning strike). Pilot, Adj P. Vereecke, *350ème/1W*. Cat.2 at Helchteen 24.7.67. Hit by ricochet during gunnery practice. Pilot Cdt A. Ronge. Cat.1 at Beauvechain 27.5.69. Heavy nose wheel shimmy on take-off. Olt A. Taminiaux aborted take-off and aircraft was stopped by barrier. Cat.2 at Beauvechain 23.6.72. To Turkey as 082 8.8.83. Later withdrawn from use at Mürted and used as decoy at Bandirma AB, Turkey. Preserved at Bandirma as 4-082. |
| 9062 | FX-28 | TOC at Gosselies 6.4.64 and issued to *349ème/1W*. To Turkey as 062 4.8.83. |
| 9063 | FX-29 | TOC at Gosselies 27.1.64 and issued to *350ème/1W*. Cat.1 in flight 21.7.65. Lost part of vertical fin. ADC W. Van de Perre unhurt. Cat.2 at Beauvechain 10.3.66. Accidental ejection of canopy due to maintenance error. Sgt G. Bonlaron injured. To Turkey as 063 29.1.81. |
| 9064 | FX-30 | TOC at Gosselies 21.2.64 and issued to *349ème/1W*. Cat.4 at Beauvechain 8.9.66. Cylinder assembly broken in undercarriage during start-up phase. Maj Wally D'Haese unhurt. To Turkey via Rimini, 17.5.83 as 064 (later 4-064, 9-064 and 4-064). |
| 9068 | FX-31 | TOC at Gosselies 13.2.64 and issued to *350ème/1W*. Cat.2 at Beauvechain 14.1.65. Heavy nose-wheel shimmy on landing. Adj W. van de Perre, pilot. To Turkey as 068 29.1.81. SOC 8.8.83. |
| 9069 | FX-32 | TOC at Gosselies 21.2.64 and issued to *349ème/1W*. Cat.1 in flight 18.6.64. Infrared glass broken. Capt J. Lehardy unhurt. To Turkey as 069 via Rimini 17.5.83. Became 4-069. |
| 9070 | FX-33 | TOC at Gosselies 27.2.64 and issued to *350ème/1W*. Cat.2 at Helchteren 17.1.68. Hit by ricochet during air-to-ground gunnery training. Cpn Pypaert unhurt. To Turkey as 070 29.1.81. |
| 9071 | FX-34 | TOC at Gosselies 9.3.64 and issued to *349ème/1W*. Cat.1 at Solenzara 2.12.64. Lost dart. Capt R. Corremans unhurt. Heavy nose-wheel shimmy on take off 10.12.64. Take-off aborted and barrier engaged. Pilot Adj E. Swanepoel. In 1973 displayed in front of the Officers Mess at 'Domaine La Chise' (Beauvechain). To Turkey as 971 22.4.82. |
| 9072 | FX-35 | TOC at Gosselies 6.3.64 and issued to *350ème/1W*. Cat.2 at Beauvechain 1.12.64. Canopy and electronics bay hatch blown by jet blast. Adj W. Van de Perre unhurt. Cat.5 at 5km off Corsican coast 25.4.78. SLt Freddy Antheunis ejected successfully. |
| 9073 | FX-36 | TOC at Gosselies 21.3.64 and issued to *349ème/1W*. Cat.5 at Nordhorn 20.6.68 during gunnery practice over the range. Capt Jacques Huygen, *31ème/10W*, killed. |
| 9077 | FX-37 | TOC at Gosselies 27.3.64. and issued to *349ème/1W*. Cat.2 at Beauvechain 17.4.68. Heavy landing on return from a night mission. SLt. A. Desmittere unhurt. Cat.5 at Mörsen (Twistringen) 13.11.73. SLt. Jozef Verdonck flew into a house on a low-level mission due to bad estimation of horizontal and vertical distances. Pilot and four civilians killed, one civilian injured. |
| 9078 | FX-38 | TOC at Gosselies 11.5.64 and issued to *349ème/1W*. To Turkey as 078 29.1.81. |
| 9079 | FX-39 | TOC at Gosselies and issued to *349ème/1W* 11.5.64. Withdrawn from use 21.12.79. Used as instructional airframe at Royal Technical School at Saffraanberg. |
| 9083 | FX-40 | TOC at Gosselies 25.8.64 and issued to *350ème/1W*. To Turkey as 083 25.2.81. |
| 9084 | FX-41 | TOC at Gosselies 20.3.64 and issued to *350ème/1W*. Delivered by Capt Ronge to *31ème/10W* 6.4.64 as first F-104G of *10W*. Withdrawn from use 10.5.83 and stored. SOC in January 1987 and sold to Radcomm Enterprise. In 1991 to Kleine Brogel to be used for ABDR. Parts used to restore FX-94 and FX-100. |
| 9085 | FX-42 | TOC at Gosselies and issued to *23ème/10W* 29.4.64. Cat.5 at Vlieland, Netherlands 30.9.70. SLt Paul Van Edom killed. |
| 9086 | FX-43 | TOC at Gosselies and issued to *23ème/10W* 14.5.64. Cat.5 at Corbais 09.00 hrs 26.1.73. Power loss on take-off due to fuel problems. Cdt Paul Naime, Wing Ops, ejected successfully. |
| 9087 | FX-44 | TOC at Gosselies and issued to *23ème/10W* 20.4.64. Cat.4 at Helchteren 7.12.72. Aircraft hit by ricochet during air-to-ground gunnery practice. Pilot, 1Lt Legros. Cat.2 at Beauvechain 16.1.73. Bird strike on take-off. Pilot, Adj J. Vanhaesendonck. Cat.2 at Solenzara 25.7.74. Lost pylon rack during taxi due to technical problem. Pilot, ADC H. Devos. Withdrawn from use and stored 7.5.81. SOC January 1987. Engine tested and restored to flying condition in 1989. To Taiwan in October 1990. |
| 9088 | FX-45 | TOC at Gosselies and issued to *23ème/10W* 29.4.64. SOC January 1987 and sold to Radcomm Enterprise. Stripped of all useful parts in 1989 and on 25.3.89 transported by road to Ledeberg (Ghent) and displayed in front of the local Volvo dealer (Burgermeester Crommenlaan, 9050 Ledeberg). On display in 1997 as 'D8030' at BMW dealer Piet Smedts at Baarlo, Netherlands. |
| 9089 | FX-46 | TOC at Gosselies and issued to *23ème/10W* 21.5.64. Cat.5 at Nordhorn range at 10.13 hrs 15.1.76. Loss of control at low altitude at high-speed due to 'pilot induced oscillation'. Capt Martin Vleminckx killed. |
| 9090 | FX-47 | TOC at Gosselies and issued to *23ème/10W* 25.4.66. Cat.2 at Kleine Brogel 30.10.81. Lost part of the nose-wheel during take-off. Lt Yvan Janssens unhurt. To *31ème/10W* 1.7.82. Stripped of useful parts in 1989. To the Royal Army Museum (Aeronautical Dept) 15.7.91. |
| 9091 | FX-48 | TOC at Gosselies and issued to *23ème/10W* 14.5.64. To *350ème/1W* 1.4.80. To Koksijde 14.4.81 and withdrawn from use and stored. SOC in January 1987 and sold to Radcomm Enterprise. Engine tested and restored to flying condition in 1989. To Taiwan AF in October 1991. |
| 9092 | FX-49 | TOC at Gosselies and issued to *23ème/10W* 30.6.64. Cat.5 at Vliehors, Netherlands, 24.11.69 during night-flight over Vlieland gunnery range. SLt Guy Mathot, *31ème/10W*, killed. |
| 9093 | FX-50 | TOC at Gosselies and issued to *23ème/10W* 4.5.64. Cat.5 at Biez 10.7.72. Mid-air collision with FX-73 over Wavre. Lt Col Louis Brignola (OSN – Wing Commander) ejected successfully. |
| 9094 | FX-51 | TOC at Gosselies and issued to *23ème/10W* 14.7.64. Cat.2 at Beauvechain 24.1.73. Anti-ice ducts detached in flight. Capt R. Van Thielen unhurt. To *31ème/10W* 1.7.82. SOC in January 1987 and sold to Radcomm Enterprise. Stripped of all useful parts in 1989. To USA 20.6.89. Sold 20.5.90 for $14,000 to unknown buyer at the Santa Monica Museum of Flying auction. Preserved by Warren Sessler, Inc. 6.90. Sold in 1992 to Flying Tigers Warbird Museum at Kissimmee, Florida. Now preserved at Kissimmee as '60813/FG-813'. |

### ***Force Aérienne Belge*** **(*FAé*)/*Belgische Luchtmacht* (*BLu*) Starfighter Inventory (SABCA-Built F-104Gs)** *(continued)*

| *C/n* | *Serial* | *Notes* |
|---|---|---|
| 9095 | FX-52 | TOC at Gosselies and issued to *23ème/10W* 8.6.64. To *31ème/10W* 9.8.73. Painted in 'Tiger' colours 6.78 for the 1978 'Tiger-Meet' at Kleine Brogel. Cat.3 at Neffe (Dinant) 10.11.81 after mid-air collision with FX-11. 1Lt Yvan Janssens, *31ème/10W*, managed a perfect emergency landing at Kleine Brogel. Aircraft repaired using tail-section of FX-86. Withdrawn from use and stored 24.6.83. SOC in January 1987 and sold to Radcomm Enterprise. Stripped of all useful parts and transferred, 15.7.91 to the Royal Army Museum. |
| 9096 | FX-53 | TOC at Gosselies and issued to *23ème/10W* 22.5.64. Cat.2 at Beauvechain 18.2.72. 3rd stage turbine/scoop broken. Cdt F. Dasseville unhurt. To *350ème/1W*. Cat.2 at Beauvechain 13.2.74. SLt Jean-Claude Timmermans hit trees on finals in TACAN after night flight. Pilot unhurt. To Saffraanberg 1.10.79 for use as instructional airframe. SOC 1.78 and sold to Radcomm Enterprise. Stripped of all useful parts and restored and displayed as gate guardian in front of the Technical School at Saffraanberg 4.4.89. |
| 9097 | FX-54 | TOC at Gosselies and issued to *23ème/10W* 1.6.64. Cat.2 at Beauvechain 22.3.73. Blown tyre on landing. ADC Tricot unhurt. To *350ème/1W* 1.4.80. Cat.5 at Authe 15.30 hrs 16.9.80. Flame-out and fire. Capt Theo Everaert ejected successfully. |
| 9098 | FX-55 | TOC at Gosselies and issued to *23ème/10W* 21.8.64. Cat.2 at Beauvechain 13.5.69. Aircraft hit by cover of parked aircraft blown by jet blast. Col P. Dewulf unhurt. Cat.5 at Romerée 6.6.69. Accidental lowering of undercarriage in flight, which made landing impossible. Major Walter 'Wally' D'Haese, visiting Staff pilot 1W, ejected but was killed when his chute failed to open properly. |
| 9099 | FX-56 | TOC at Gosselies and issued to *10W* 17.7.64. To *1W* 29.12.66–6.67. Cat.2 at Solenzara, Corsica, 18.7.73. Round explosion. Pilot 1Lt J. Bernard. Cat.2 at Beauvechain 30.10.75. Blown tyre on take-off. Pilot Capt Jules Jacob. Cat.2 at Beauvechain 20.11.75. Bird strike on landing. Pilot Maj F. Wirtz. Cat.5 14.2.77. After flame-out SLt Gerald Dessart made an emergency landing at Beauvechain. He was injured and his aircraft was completely burnt out. |
| 9100 | FX-57 | TOC at Gosselies 15.5.64. Cat.1 in flight 18.6.64. Infra red glass broken. Adj T. Grisard unhurt. To *10W* 4.6.65–25.4.66. To *1W* 15.1.73. Suffered bird strike 23.4.74. 1Lt Mignon unhurt. To *23ème/10W* 14.8.75. Cat.2 at Macquenoise 18.8.78. Loss of flap. Pilot Capt M. Salmon. To *350ème/1W* 1.4.80. Withdrawn from use and stored at Koksijde 14.4.81. SOC 1.87 and sold to Radcomm Enterprise. Engine tested and restored to flying condition in 1989. To Taiwan AF in October 1990. |
| 9101 | FX-58 | TOC at Gosselies and issued to *10W* 25.6.64. To *1W* 7.2.69. Cat.2 at Beauvechain 4.3.70. Canopy damaged by jet blast. Capt Pypaert unhurt. Cat.2 at Beauvechain 23.10.73. Hit FX-67 with GSE door. Olt H.Malaise unhurt. To *350ème/1W* 1.4.80. Withdrawn from use and stored at Koksijde 15.9.80. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and made derelict in 1989. To Beauvechain in 1991 to be used for ABDR. Transported to Weelde 9.95 and stored on behalf of the Royal Army Museum. To Kepellen Royal Army Museum reserve depot in 1996. |
| 9102 | FX-59 | TOC at Gosselies and issued to *10W* 26.6.64. To *1W* 24.12.68. Cat.2 at Solenzara 3.8.73. Round exploded in flight 1Lt J. Commaerts unhurt. Cat. 2 at Helchteren 14.11.74. Round exploded in flight. Capt R. Venthielen. To *350ème/1W* 1.4.80. Withdrawn from use and stored at Koksijde 3.6.81. SOC 1.87 and sold to Radcomm Enterprise. Engine tested and aircraft restored to flying condition. To Taiwan 10.90. |
| 9103 | FX-60 | TOC at Gosselies and issued to *10W* 2.6.64. To *1W* 16.12.70. Cat.2 at Beauvechain 1.2.71. Lost canopy during taxiing. SLt J. Cammaerts unhurt. To *10W* 15.10.76. Withdrawn from use and stored at Koksijde 19.3.82. SOC and sold to Radcomm Enterprise 1.87. Stripped of all useful parts in 1989 and on 10.2.89 transported to 'Flugausstellung Leo Junior'. Hunsrückhöhenstarsse, 5508 Hermeskeil, Germany. |
| 9104 | FX-61 | TOC at Gosselies and issued to *23ème/10W* 8.6.64. To *1W* 14.10.70. Cat.2 at Beauvechain 26.10.71. Undercarriage door damaged on take-off due to a technical problem. Cdt Dirk Desplenter unhurt. Cat.2 at Beauvechain 3.11.72. Bird strike on take-off. Capt Hans Beyaert unhurt. To *10W* 13.12.74. To *31ème/10W* 1.7.82. Withdrawn from use 26.9.83. Preserved at *23ème/10W* at Kleine Brogel 4.10.83. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and used as ABDR airframe at Kleine Brogel. Sold 12.89 to the 'Tiger Air Force Museum', Steenweg op Wijchmaal, 3990 Peer. To Kleine Brogel in 1992 for Battle Damage Repair Training. In 1996 at 'Tiger Air Force Museum' (Jos Palmers) Maanlosedijk, 3990 Peer. |
| 9105 | FX-62 | TOC at Gosselies and issued to *10W* 2.7.64. To *1W* 18.9.70. Cat.2 at Helchteren 25.11.70. Hit by ricochet during air–ground gunnery practice. 1Lt H. Beyaert unhurt. Cat.4 at Beauvechain 14.4.71. Heavy landing. 1Lt Y. Debluts unhurt. Cat.2 in flight 12.5.72. Loss of tow. Cdt A. Degraeve unhurt. Cat.4 at Koksijde 21.8.74. Undercarriage drag strut broken after hard landing. Capt M. Bouret unhurt. Cat.2 at Beauvechain 7.1.76. Loss of control over aircraft upon landing due to ground air safety switch malfunction. Pilot Capt G. Van Eeckhoudt. To *350ème/10W* 1.4.80. Withdrawn from use and stored at Koksijde 29.5.80. SOC 1.87. and sold to Radcomm Enterprise. Engine tested and aircraft restored to flying condition in 1989. To Taiwan AF 10.90. |
| 9106 | FX-63 | TOC at Gosselies and issued to *10W* 3.9.64. Cat.5 at Geel (St Kristoffelstraat) 11.10.66 on low-level navigation flight. SLt Frans Exelmans, *23ème/10W*, ejected but was killed. |
| 9107 | FX-64 | TOC at Gosselies and issued to *10W* 11.8.64. To *1W* 13.12.71. To *10W* 4.8.75. Withdrawn from use and stored 22.10.81. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| 9108 | FX-65 | TOC at Gosselies and issued to *10W* 16.9.64. To *1W* 15.10.68. Cat.1 at Beauvechain 12.3.69. Capt A. Degraeve aborted take-off after heavy fumes in cockpit. Aircraft engaged barrier, pilot unhurt. To *10W* 17.2.72. Withdrawn from use and stored 19.11.81. SOC and sold to Radcomm Enterprise 1.87. To Taiwan AF. |
| 9109 | FX-66 | Cat.5 at Gosselies during demonstration flight 18.8.64. Aircraft crashed onto a hangar during a looping manoeuvre. Capt Pierre Tonet (CEV/Grosselies – SABCA Gosselies production test pilot) killed. |
| 9113 | FX-67 | TOC at Gosselies and issued to *10W* 17.7.64. To *1W* 22.12.70 Cat.2 at Beauvechain 29.6.71. Undershot runway/barrier on landing after night flight. Capt H. Bernier unhurt. Cat.4 at Tanagra, Greece, 24.3.72. Undercarriage partially collapsed duirng taxiing. SLt W. Belandsheer unhurt. Cat.2 at Beauvechain 23.10.73. Hit GSE (see FX-58). SLt J.P. Aerts unhurt. To *10W* 9.9.75. To *1W* 2.8.78. To *350ème/1W* 1.4.80. Withdrawn from use and stored 30.9.80. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| 9114 | FX-68 | TOC at Gosselies and issued to *10W* 1.9.64. To *1W* 4.71. Cat.2 at Beauvechain 16.3.73. Bird strike on landing. 1Lt J. Legros unhurt. To *349ème/1W* 9.1.76. Cat.2 at Solenzara 23.10.78. Collision in formation. Pilot SLt D. Van Rijckevorsel. Cat.5 at Gochenée 10.18 hrs 5.6.79. Flew into ground during air-to-air combat training. Cause never fully determined. SLt Benoit Paul, *349ème/1W* killed. |
| 9115 | FX-69 | TOC at Gosselies and issued to *10W* 31.8.64. To *1W* 31.1.69. Cat.2 at Beauvechain 5.1.72. Cylinder assembly broken during start-up procedure. Maj Van Hecke unhurt. Cat.2 at Solenzara 9.7.74. Taxi collision with Armée de l'Air aircraft. Maj G. D'Hert unhurt. To *10W* 7.8.75. To *1W* 15.9.77. Cat.2 at Beauvechain 12.10.79. Collision with extinguisher during taxiing. SLt P. Martin, pilot. To *350ème/1W* 1.4.80. Withdrawn from use and stored 18.7.80. SOC and sold to Radcomm Enterprise 1.87. To Royal Army Museum 15.7.91. |
| 9119 | FX-70 | TOC at Gosselies and issued to *10W* 21.8.64. To *1W* 20.5.69. To *10W* 30.10.73. Cat.2 at Helchteren 26.9.64. Aircraft hit ground during low-level navigation exercise. Left trailing edge flap damaged. Capt Fritz Hartmann unhurt. *To 1W* 4.1.77. To *350ème/1W* 1.4.80. Cat.2 at Beauvechain 6.2.80. Foreign object damage. Screw ingested into engine in flight. Pilot Olt P. Martin. To 10W 17.4.81. To *31ème/10W* 1.7.82. Withdrawn from use and stored 25.2.83. SOC 1.87 and sold to Radcomm Enterprise. Stripped of useful parts and transported to Florennes for ABDR training. |
| 9120 | FX-71 | TOC at Gosselies and issued to *10W* 18.9.64. Cat.5 at Peer 24.9.69. Capt Guy Ghijs, *31ème/10W*, ejected successfully. |
| 9121 | FX-72 | TOC at Gosselies and issued to *10W* 3.9.64. To *1W* 7.12.70. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| 9125 | FX-73 | TOC at Gosselies and issued to *10W* 25.4.66. To *1W* 7.69. Cat.5 at Biez 10.7.72 after mid-air collision over Wavre with FX-50. 1Lt Jean Marie Boulanger, *350ème/1W*, ejected successfully. |
| 9126 | FX-74 | TOC at Gosselies and issued to *31ème/1W* 9.10.64. To *350ème/1W* 6.3.69. Cat.2 at Solenzara 1.4.75. Ran off runway on landing. SLt Jean-Claude Timmermans unhurt. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan 10.90. |
| 9127 | FX-75 | TOC at Gosselies and issued to *23ème/10W* 22.9.64. Cat.5 at Peer 4.4.68. Aircraft would not take off at maximum loading. 1Lt Leonard 'Jim' Van Roy killed. |
| 9131 | FX-76 | TOC at Gosselies and issued to *31ème/10W* 26.10.64. SOC and sold to Radcomm Enterprise 1.87. Stripped of all useful parts and transported to Beauvechain for ABDR purposes. At Dhr. Maes Langedonckstraat 8 1910 Kampenhout, together with FX-100 26.3.94. |
| 9132 | FX-77 | TOC at Gosselies and issued to *31ème/10W* 5.10.64. Cat.5 at Deure, Netherlands, 27.1.65. Capt Jacques Verhulst killed. |
| 9133 | FX-78 | TOC at Gosselies and issued to *31ème/10W* 6.10.64. Cat.2 at Beauvechain 11.8.69. Hit trees on landing after night mission. SLt Robert Van Winckel unhurt. Cat.2 at Beauvechain 27.2.75. Torque arm assembly broken upon landing. SLt P. Quinet. Cat.2 at Beauvechain 26.3.75. Collision with extinguisher during taxiing. SLt Jean-Marie Paul unhurt. Cat.2 at Beauvechain 2.5.77. Blown tyre on take-off. Pilot Capt Robert Van Winckel. To *31ème/10W* 1.7.82. Withdrawn from use and stored 18.5.83. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and transported to Beauvechain to be used for ABDR training. To Royal Army Museum 9.95. |
| 9137 | FX-79 | TOC at Gosselies and issued to *31ème/10W* 6.10.64. Cat.4 14.12.79 at Beauvechain. Loss of control of aircraft due to oil loss on take-off. SLt L. Van Landeghem. SOC 3.10.80. Sold to scrap dealer Mr Van Nieuwenhuyse at Kalken in 1981. Sold in the mid-eighties to Mr Maurice De Groote Rivierstraat 61 9080 Beervelde, who displayed the aircraft on top of some containers as an eye-catcher for his firm. |
| 9138 | FX-80 | TOC at Gosselies and issued to *31ème/10W* 19.10.64. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan 10.90. |
| 9139 | FX-81 | TOC at Gosselies and issued to *349ème/1W* 8.4.66. Bad function of ejection system 3.8.72. 1Lt Robert Van Winckel unhurt. To *23ème/10W* 19.9.78. Cat.2 at Diepenbeek 9.2.79 after mid-air collision with FX-95 (flown by Frank Naets, killed) while holding in the vicinity of Hasselt prior to air-to-ground firing at the 'Pampa Range' at Helchteren. SLt Peter Naets (twin brother of Frank) made a successful emergency landing at Kleine Brogel. Horizontal stabilizer damaged. Withdrawn from use and stored 19.4.82. Sold to Radcomm Enterprise 1.87. Stripped of all useful parts. Preserved at Pennsaukin, New Jersey, USA. |
| 91240 | FX-82 | TOC at Gosselies and issued to *349ème/1W* 10.11.64. To *31ème/10W* 1.7.82. Withdrawn from use and stored 21.10.82. SOC and sold to Radcomm Enterprise 1.87. Stripped of all useful parts and left for the USA, 20.6.89. Preserved at Planes of Fame Museum, Chino, USA. |
| 9141 | FX-83 | TOC at Gosselies and issued to *349ème/1W* 6.1.65. Cat.2 at Beauvechain 24.3.73. Heavy nose shimmy after blown nose wheel tyre on landing. Capt J. Henrotte unhurt. Aircraft used by 'Slivers' aerobatic team in 1973. To *10W* 27.6.77. Withdrawn from use and stored 11.2.82. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and remains used at Florennes for ABDR 15.7.91–2.95. Stored at Weelde on behalf of Royal Army Museum. |
| 9142 | FX-84 | TOC at Gosselies and issued to *349ème/1W* 25.2.66. Cat.2 after forced landing at Leeuwarden, Netherlands, 18.8.66. Bullet destroyed tube assembly during gunnery practice. Cat.4 at Tanagra, Greece, 6.11.72. Partial collapse of undercarriage in landing. Cdt D. Loriers unhurt. Withdrawn from use and stored 10.12.81. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and aircraft sent to USA 20.6.89. To Mineral Wells Municipal Airport, Texas in 1989. At Mojave 5.90. Registered N104PJ 7.98. |
| 9146 | FX-85 | TOC at Gosselies and issued to *1W* 7.7.66. Cat.4 at Beauvechain 12.4.67. Collapse of undercarriage leg, strut broken. Cdt Lehardy unhurt. Withdrawn from use and stored 27.2.81. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts. To Florennes for ABDR 15.7.91. Stored on behalf of the Royal Army Museum 9.95. |
| 9147 | FX-86 | TOC at Gosselies and issued to *1W* 21.9.66. Cat.3 at Beauvechain 2.4.68. Loss of control during taxiing. SLt C. Evraert. Cat.2 at Beauvechain 4.3.70. Canopy damaged by jet blast during taxiing. ADC J. Elen. Cat.4 at Helchteren 4.3.70. Aircraft hit by ricochet during air-to-ground gunnery practice. Capt J. Henrotte. Cat.3 at Jever, Germany, 26.6.81. Bird Strike in intake over Diepholz. Lt Erwin De Decker unhurt. Withdrawn from use 26.6.81. 1.7.81 gate guardian in front of *31ème/10W* dispersal at Kleine Brogel. |
| 9148 | FX-87 | TOC at Gosselies 1965 and issued to *1W* 10.66. Cat.5 at Beauvechain 2.9.68 during low-level aerobatics during filming for the TV series 'Les Chevaliers du Ciel'. Capt Francois Jacobs (Sus) (*350ème/1W*) performed a touch-roll-touch on the runway and after the roll his afterburner did not light immediately. He was killed in unsuccessful ejection since he pulled the D-ring when the aircraft was at an angle of 90°. |
| 9152 | FX-88 | TOC at Gosselies 1965 and issued to *1W* 2.67. Cat.5 at Rienne 20.4.67 following loss of control during dogfight with Mirage. SLt Pierre Rassart, *349s/1w* ejected successfully. |

**_Force Aérienne Belge_ (_FAé_)/_Belgische Luchtmacht_ (_BLu_) Starfighter Inventory (SABCA-Built F-104Gs)** *(continued)*

| *C/n* | *Serial* | *Notes* |
|---|---|---|
| 9153 | FX-89 | TOC at Gosselies 23.2.65. and issued to *1W* 20.2.67. To *10W* 27.6.69. Cat.2 at Kleine Brogel 16.10.73. To *1W* 6.7.77. To *350ème/1W* 1.4.80. Withdrawn from use and stored 14.4.81. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and aircraft stored on behalf of the Royal Army Museum 9.95. |
| 9154 | FX-90 | TOC at Gosselies 23.2.65 and issued to *1W* 8.2.67. Withdrawn from use and stored 23.9.82. SOC and sold to Radcomm Enterprise 1.87. Hit by Bölkow B0105P 87+24 of the German Army during its display routine at the annual airshow at Koksijde 9.7.87. Extensive tail damage. FX-90 was stripped of all useful parts in 1988 and transported on 14.11.88 to Savigny-les-Beaune to be displayed in the collection of Mr Michel Pont, Chateau de Savigny-les-Beaune, 21420 Savigny-les-Beaune, France. |
| 9158 | FX-91 | TOC at Gosselies and issued to *10W* 5.4.65. To *1W* 3.68.–9.71. To *23ème/10W* 1977. Cat.5 in Ijselmeer off Staveren, Netherlands 20.30 hrs 2.8.78 when it crashed into the Ijselmeer during a night-flight. SLt Rudiger Smet had suffered spacial disorientation and was killed. |
| 9159 | FX-92 | TOC at Gosselies and issued to *10W* 8.2.65. Cat.5 at Kaulille 9.9.65 after the aircraft became uncontrollable after a loop at low level during an aerobatic demonstration. Maj Hadelin D'Hoop, CO *23ème/10W*, ejected but was killed. |
| 9160 | FX-93 | TOC at Gosselies 23.3.65.and issued to *10W* 3.1.66. Withdrawn from use and stored 6.4.82. SOC and sold to Radcomm Enterprise 1.87. Stripped of all useful parts. Preserved at the Orange airfield, France. Later removed to air park 'Zruc' near Pilzen, Czechoslovakia. |
| 9164 | FX-94 | TOC at Gosselies 9.3.65 and issued to *1W* 2.3.67. To *31ème/10W* 1.7.82. Withdrawn from use and stored 22.6.83. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and in 1998 aircraft was used as a monument. |
| 9165 | FX-95 | TOC at Gosselies 24.2.65 and issued to *1W* 22.2.67. Cat.2 at Solenzara, Corsica, 14.9.67. Dart hit aileron during target towing. ADC Leo Mommens unhurt. To *23ème/10W* 8.9.77. Cat.5 at Diepenbeek 14.47 hrs 9.2.79. SLt Frank Naets killed. (Midair collision with FX-81 (flown by his twin brother Peter) while holding in the vicinity of Hasselt prior to air-to-ground firing at the 'Pampa Range' at Helchteren.) Olt Peter Naerts in FX-81 made a successful emergency landing at Kleine Brogel. |
| 9166 | FX-96 | TOC at Gosselies 23.3.65 and issued to *1W* 23.3.67. To 31ème/10W 1.7.82. Withdrawn from use and preserved at Kleine Brogel 7.10.83. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and used for ABDR training at Kleine Brogel. |
| 9170 | FX-97 | TOC at Gosselies 23.3.65 and issued to *1W* 16.3.67–4.69. To *31ème/10W* 26.9.69. Cat.5 at Alten Hellefeld/Südern, Denmark, 15.17 hrs 25.7.73 after pilot misjudged vertical and horizontal distances. Major Gilbert Masselis, visiting staff pilot, flew into the ground after attacking target on FAC mission. Pilot killed. |
| 9171 | FX-98 | TOC at Gosselies 23.3.65 and issued to *1W* 5.5.67–9.71. Cat.5 at Ospel, Netherlands, 15.05 hrs 2.8.77. Possible stall on landing – cause never determined. SLt Adelin D'Haese, *31ème/10W*, ejected but was killed when his chute failed to open. |
| 9172 | FX-99 | TOC at Gosselies 2.4.65 and issued to *1W* 12.4.67. Last used by *31s/10W* on 26.9.83. when it was flown by Capt Aerts. Withdrawn from use and stored. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and sold for restoration to Steve Alex, 60 Union Street, Belfast, Maine 04915, USA in 1992. Now displayed at Canadian Warplane Heritage at Hamilton, Ontario. |
| 9176 | FX-100 | TOC at Gosselies 9.5.65 and issued to *1W* 8.5.67. To *10W* 6.8.69. Withdrawn from use and stored 28.1.82. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and transported to Kleine Brogel for display. Since 26.3.94 displayed with FX-76 at Kempenhout. |

**Lockheed TF-104G Starfighters of the _Force Aérienne Belge_ (_FAé_)/_Belgische Luchtmacht_ (_Blu_)**

| *C/n* | *Serial* | *Notes* |
|---|---|---|
| FC-01 | | (583D-5786) (64-15104/FG-104). TOC at Lockheed/Palmdale 11.12.64 and issued to *OCF/1W* at Beauvechain 25.1.65. Last used by *10W* 30.3.80. Withdrawn from use and stored 17.8.80. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| FC-02 | | (583D-5787) (64-15105/FG-105). TOC at Lockheed/Palmdale 18.1.65 and issued to *OCF/1W* at Beauvechain 25.1.65. Cat.2 at Beauvechain 26.6.67. Rear canopy unlocked and torn off on take-off. Pilot 1Lt de Fabri Beckers unhurt. Last used by *31ème/10W* 1.7.82. Withdrawn from use and stored 14.2.83. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| FC-03 | | (583D-5788) (64-15106/FG-106). TOC at Lockheed/Palmdale 23.2.65 and issued to *OCF/1W* at Beauvechain 8.3.65. Last used by *OCF/1W* 30.1.81. Withdrawn from use and stored 30.10.81. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| 5101 | FC-04 | TOC at Gosselies and issued to *OCF/1W* 20.9.67. Last used by *31ème/10W* 1.7.82. Withdrawn from use and stored 4.10.83. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| 5102 | FC-05 | TOC at Gosselies and issued to *OCF/1W* 8.4.64–9.68. In flight bird strike 10.6.74. ADC Jan Govaerts and Capt M. Bouret unhurt. Cat.5 at Neunkirchen, Germany 12.5.80 following a bird strike. Capt Alex Peelaers and SLt Emmanuel Goossens ejected successfully but aircraft crashed on a factory killing three people. |
| 5103 | FC-06 | TOC at Gosselies (was registered FX5103 during SABCA test flights) and issued to *OCF/1W* 18.12.67. Last used by *31ème/10W* 1.7.82. Withdrawn from use and stored 16.2.83. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| 5104 | FC-07 | TOC at Gosselies 21.12.67 and issued to *OCF/10W* 4.1.68. Last used by *31ème/10W* 1.7.80. Withdrawn from use and stored 4.5.83. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| 5105 | FC-08 | TOC at Gosselies 16.2.68.and issued to *OCF/10W* 28.2.68. Last used by *OCF/10W* 31.8.79. Transported to Koksijde 26.3.81 for load trials in a C-130. Tail damaged during trials. SOC 1.87 and sold to Radcomm Enterprise. Stripped of all useful parts and transported by road to Savigny-les-Beaune 14.11.88 for display at local air museum. |
| 5106 | FC-09 | TOC at Gosselies and issued to *OCF/1W* 31.1.68. Flown by King Baudouin during official visit at Beauvechain (pilot Capt Leo Lambermont). Cat.5 at Mont-St Guibert 1230hrs 19.6.69 after Cdt Henri Loots accidentally bailed out ADC Leo Mommens ejected successfully after control of aircraft was lost. Both occupants severely injured. |
| 5107 | FC-10 | TOC at Gosselies and issued to *OCF/1W* 1.3.68. Last used by *OCF/10W* 14.4.81. Withdrawn from use and stored 6.11.81. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| 5108 | FC-11 | TOC at Gosselies 16.2.68 and issued to *OCF/10W* 1.3.68. Suffered minor Cat damage on three occasions 1971–74. Was last used by *31ème/10W* 26.9.83 when it was flown by ADC John Lemmens and 1Lt Steens. Lemmens accumulated more hours on F-104s – 3,007 hrs – than any other Belgian F-104 pilot. Withdrawn from use and stored 27.9.83. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |
| 5109 | FC-12 | TOC at Gosselies 25.3.68 and issued to *OCF/1W* 29.3.68. Last used by *31ème/10W* 1.7.82. Withdrawn from use and stored 25.3.83. SOC 1.87 and sold to Radcomm Enterprise. To Taiwan AF 10.90. |

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CHAPTER EIGHT

# World-Wide Military Operators

## Japan

In Japanese service the Starfighter, or the *Eiko* (Glory), as it was known, equipped seven *Hiko-tais* (squadrons) of the *Nihon Koku Jieitai* (Japanese Air Self-Defence Force, or JASDF), 1966–86. Altogether, some 210 F-104Js and twenty F-104DJ operational trainers entered service with the JASDF. The first unit equipped was the 201st *Hiko-tai*, a provisional training unit, at Komaki Air Base on 22 March 1962, which after receiving its full complement of F-104Js, moved to Chitose in northern Japan in September and began training that December. Next to equip with the F-104J was the *202nd Hiko-tai*, at Nyutabaru AB on Kyushu. Next, the *203rd Hiko-tai* was activated on 25 June 1964 and it began assuming an alert mission in December. On 22 January 1965 the *203rd Hiko-tai* received its first 'hot' scramble. These three *Hiko-tais* were followed by two more *Hiko-tais* – the *204th* and the *205th* (the latter activated on 28 December 1964). On 20 December 1965 the *206th Hiko-tai* was activated and on 31 March 1966 the *207th Hiko-tai* was activated, both squadrons forming the 7th Wing. Their alert mission began on 22 August 1967. The *201st* and *203rd Hiko-tais* formed the 2nd Air Wing, the *202nd* and *204th Hiko-tais*, the 5th Air Wing, and the *205th Hiko-tai* became a part of the 6th (Composite) Air Wing.

All F-104Js used operationally by the Nihon Koku Jieitai were optimized for the airborne interception role, normally carrying four AIM-9 Sidewinder AAMs and two underwing fuel tanks (no other stores were carried as the Japanese constitution bans weapons and aircraft with an offensive capability).

On 12 June 1981 the JASDF reduced its Starfighter *Hiko-tais* from seven to four squadrons, leaving some 165 F-104J/F-104DJs to be operated by the *202nd* and *204th Hiko-tais* at Nyutabaru, the *203rd* at Chitose, the *205th* at Komatsu, and the *207th* at Naha. Beginning in December 1981, the F-104Js were progressively replaced by Mitsubishi-built F-15J/-15DJs. Some twenty-seven F-104Js and five F-104DJs (the latter were used for spare parts) were acquired by the Nationalist Chinese Air Force on Taiwan. The last F-104J Starfighters in Japanese Self-Defence Force service were retired by the *207th Hiko-tai* at Naha in March 1986 and sent to the Air Proving Wing at Gifu for storage. A number were converted to drone aircraft.

**The first F-104J for the** Nihon Koku Jieitai **(Japanese Air Self Defence Force/JASDF) being prepared for its first flight. Mitsubishi delivered F-104Js to the JASDF from March 1962–67. All were used in the interceptor role by seven** Hiko-tais **(squadrons) (201st–207th) of the JASDF.** Lockheed

**Specification – Lockheed Mitsubishi F-104J**

| | |
|---|---|
| Type: | (F-104J) multi-role, all-weather fighter<br>(F-104-DJ) trainer |
| Crew: | (F104J) Pilot only. (F-104DJ) Pilot and student |
| First Flight: | 30 June 1961 (Lockheed-produced F-104J). Japan, 9 March 1962 |
| Number built: | 210 (3 by Lockheed; Mitsubishi: 29 F-104Js from Lockheed-built components plus 178 built in Japan) |
| Powerplant: | One 10,000lb (4,540kg) static thrust, 15,600lb (7,080kg) afterburning Ishikawajima-Harima-built J79-IHI-11A turbojet |
| Dimensions: | Span, without tip tanks, 21ft 9in (6.62m); wing area, 196.1sq ft (18.21$\text{m}^2$); length, 54ft 8in (16.66m); height, 13ft 5in (4.08m) |
| Empty weight | 13,996lb (6,348kg) |
| Combat weight: | 20,640lb (9,360kg) |
| Max take-off weight: | 29,038lb (13,172kg) |
| Performance: | Max speed, 1,146mph (1,844km/h) at 50,000ft (15,240m), 1,328mph (2,137km/h) at 35,000ft (10,670m)<br>Cruising speed, 510mph (821km/h)<br>Climb in one minute, 48,000ft (14,630m)<br>Service ceiling, 50,000ft (15,240m)<br>Absolute ceiling, 90,000ft (27,430m)<br>Range, 1080 miles (1,738km)<br>Maximum range, 1,630 miles (2,623km) |
| Fuel: | Normal, 897 USgal (3,395l)<br>Maximum, 1,784 USgal (6,617l) |
| Armament: | One 20mm M-61 Vulcan rotary cannon, four AIM-9 Sidewinder AAM missiles |

***(Top)* F-104J 26-8501, the first of the Mitsubishi-built F-104J Starfighters for the** Nihon Koku Jieitai **(Japanese Air Self Defence Force/JASDF).** via Philip Jarrett

***(Bottom)* F-104J 46-8651 of the** Nihon Koku Jieitai **(Japanese Air Self Defence Force/JASDF). Beginning in December 1981, the F-104Js were progressively replaced by Mitsubishi-built F-15J/-15DJs until the last Starfighters were retired by the** 207th Hiko-tai **at Naha in March 1986.** via Philip Jarrett

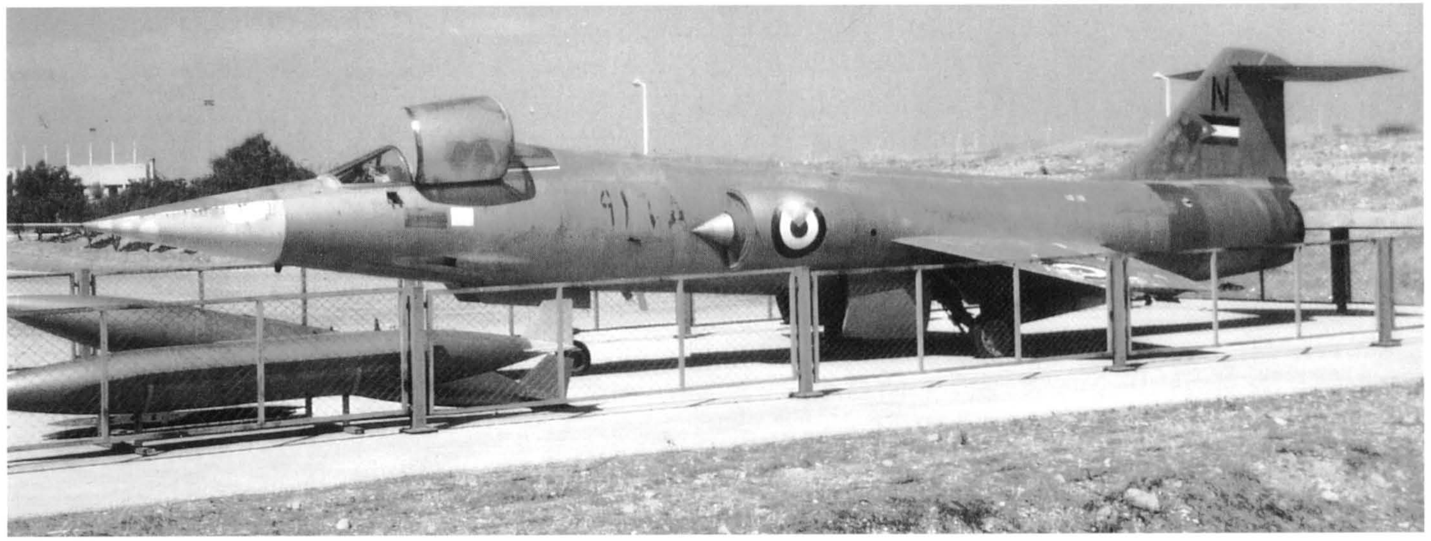
**F-104DJ trainers for the** Nihon Koku Jieitai **(Japanese Air Self Defence Force/JASDF) at the Mitsubishi plant in December 1962.** *Aeroplane*

***(Below)* Japanese pilots on the ramp at Lockheed's Palmdale plant in October 1968 when the Japanese Self Defence Force sent a team of pilots to the Lockheed plant to evaluate the F-104S as a follow-on version to the F-104J. The S version for the** Nihon Koku Jieitai **(Japanese Air Self Defence Force/JASDF) was designated the CL-1010 but Japan decided against procuring this version of the Starfighter.** *Aeroplane*

***(Bottom)* Ex-Republic of China (RoCAF/Taiwan Air Force) F-104A (56-0845) 916/'N' of the** Al Quwwat Aljawwiya Almalakiya Alurduniya **(Royal Jordanian Air Force), now displayed at Irbid.** Ton van der Zeeuw

## Jordan

Jordan acquired twenty-nine F-104As and four F-104Bs, fifteen and three of which respectively, were formerly operated by the Nationalist Chinese Air Force in Taiwan until late in 1966. Initial deliveries to the *Al Quwwat Aljawwiya Almalakiya Alurduniya* (Royal Jordanian Air Force) were begun in the spring of 1967, to No.9 Squadron at Prince Hassan Air Base. Two days before the June 1967 Six-Day Arab–Israeli war the US removed the F-104s to Turkey. After the war ended the US refused to return the Starfighters to Jordan but after it appeared that King Hussein might turn to the Soviet Union and accept MiG-21s, the US relented and agreed to supply Jordan. Reissue of the (now refurnished) F-104As and four F-104Bs to No.25 Squadron at Mwaffaq Salti Air Base began in mid-1969.



One of the Jordanian Starfighters saw combat during the failed coup against King Hussein in November 1972. The F-104/Bs were gradually replaced by the Northrop F-5E Tiger II and the last Starfighters were finally replaced by Dassault Mirage FICJs in 1982–83. The survivors saw final service as airfield decoys.

## Pakistan

Pakistan, which remained an important ally of the United States through the Cold War, was the first non-NATO country to equip with the Starfighter. By September 1965, when hostilities broke out with its immediate neighbour India, the Pakistan Air Force (PAF) had only 150 aircraft (including 102 F-86Fs), while the Indian Air Force (IAF) possessed approximately 900 aircraft. Twelve of the aircraft in the PAL inventory were Starfighters, the bulk of which were received in August 1961.These consisted of ten refurbished F-104As and two F-104Bs, all supplied under the US Military Defense Assistance Programme (MAP).

**Starfighters of the *Al Quwwat Aljawwija Almalakiya Alurduniya* (Royal Jordanian Air Force)**

| *Serial* | *Type* | *RJAF Serial* | *Notes* | *Current Disposition* |
|---|---|---|---|---|
| 57-1294 | F-104B | 900/A | ex-Taiwan 10.66 | At Azraq/Al-Salti AB |
| 57-1296 | F-104B | 901/B | ex-Taiwan 10.66 | At Thunderbird Aviation (N65354) |
| 57-1298 | F-104B | 902/C | ex-Taiwan 10.66 | Preserved at Mafraq |
| 56-0767 | F-104A | 903 | ex-Taiwan 10.66 | Crashed 1 November 1971 |
| 56-0774 | F-104A | 904 | ex-Taiwan 10.66 | Crashed 16 July 1974 |
| 56-0775 | F-104A | 905/D | ex-Taiwan 10.66 | Decoy at Prince Hassan AB |
| 56-0777 | F-104A | 906 | ex-Taiwan 10.66 | Crashed 14 September 1972 |
| 56-0778 | F-104A | 907/E | ex-Taiwan 10.66 | Stored Air Inter Corp., Dallas (N66305) |
| 56-0780 | F-104A | 908/F | ex-Taiwan 10.66 | FOX-11, Addison Apt, FG-780 (N66342) |
| 56-0786 | F-104A | 909/G | ex-Taiwan 10.66 | Stored at Mojave CA (N66328) |
| 56-0788 | F-104A | 910/H | ex-Taiwan 10.66 | Decoy at Prince Hassan AB |
| 56-0789 | F-104A | 911/I | ex-Taiwan 10.66 | Displayed at de Mouta Univ., Jordan |
| 56-0797 | F-104A | 912/J | ex-Taiwan 10.66 | Decoy at Prince Hassan AB |
| 56-0799 | F-104A | 913/K | ex-Taiwan 10.66 | Preserved at Mafraq |
| 56-0839 | F-104A | 914/L | ex-Taiwan 10.66 | At Azraq/Al-Salti AB |
| 56-0843 | F-104A | 915/M | ex-Taiwan 10.66 | Preserved at Mafraq |
| 56-0845 | F-104A | 916/N | ex-Taiwan 10.66 | At Irbid |
| 56-0850 | F-104A | 917 | ex-Taiwan 10.66 | Crashed 6 June 1971 |
| 56-0771 | F-104A | 918/O |  | At King Abdullah AB |
| 56-0791 | F-104A | 919/P |  | Gate guard at King Hussein Air College |
| 56-0811 | F-104A | 920/Q |  | Decoy at Prince Hassan AB |
| 56-0824 | F-104A | 921/R |  | Crashed 15 December 1974 |
| 56-0782 | F-104A | 922/T |  | At Azraq/Al-Salti AB |
| 56-0793 | F-104A | 923/S |  | At Azraq/Al-Salti AB |
| 56-0834 | F-104A | 924/U |  | At Prince Hassan AB |
| 57-1304 | F-104A | 925/V |  | Decoy at Mafraq |
| 56-0849 | F-104A |  |  |  |
| 57-1302 | F-104B |  |  |  |

**F-104A 56-804 of the Pakistan Air Force over the Himalayas.** PAF

At PAF's request, all its F-104s were refitted with the M-61 gun, whereas the USAF had removed the weapon on the assumption that air combat after Korea would occur at high speeds where only AAMs would be effective. This and the more advanced GE-J-79-11 engine made the PAF F-104s unique – they had the gun and being the lightest of the F-104 series, therefore enjoyed the best thrust-to-weight ratio.

All were used to equip No.9 Air superiority Squadron (which today flies the F-16). This became an elite unit, its personnel hand-picked from F-86 Sabre squadrons. The PAL Starfighters, which were each armed with two AIM-9B Sidewinder AAMs, were the first Mach 2 capable aircraft in Asia. Even in Europe at this time, most countries were still flying subsonic aircraft. Even before its introduction to combat the Starfighter had gained such a reputation in IAF circles that it was known as the 'badmash', 'scoundrel' or 'wicked one'.

Many questioned Pakistan's ability to fly and maintain such a sophisticated aircraft as the F-104A/B. (The in-commission rate of the F-104 during the first five years of service was over 80 per cent and all systems performed with high reliability). No.9 Squadron lost only one Starfighter during training, when Flt Lt Asghar 'pitched up' and went into an uncontrollable spin during an air combat training sortie. This F-104A was replaced under the MAP programme. Also, Flt Lt Khalid managed a 'dead stick' landing after an engine flame-out in another F-104A.

During the 1965 war No.9 Squadron was commanded by Sqn Ldr Mervyn Leslie Middlecoat who, as a flight lieutenant, was, with Sqn. Ldr Mian Sadruddin, one of the two pilots to land the first pair of PAL Starfighters at Sargodha in 1962. India had radar cover above 5,000ft (1,524m) which made it virtually impossible for the Starfighter to achieve surprise, while subsonic aircraft operating under radar cover could easily defend themselves. At first, most thought that the chance of a real war breaking out between the two countries was high, and morning Combat Air Patrol (CAP) was flown before dawn. The F-104s would fly to 30,000ft (914om) and patrol the area near the disputed territory of Indian-held Kashmir.

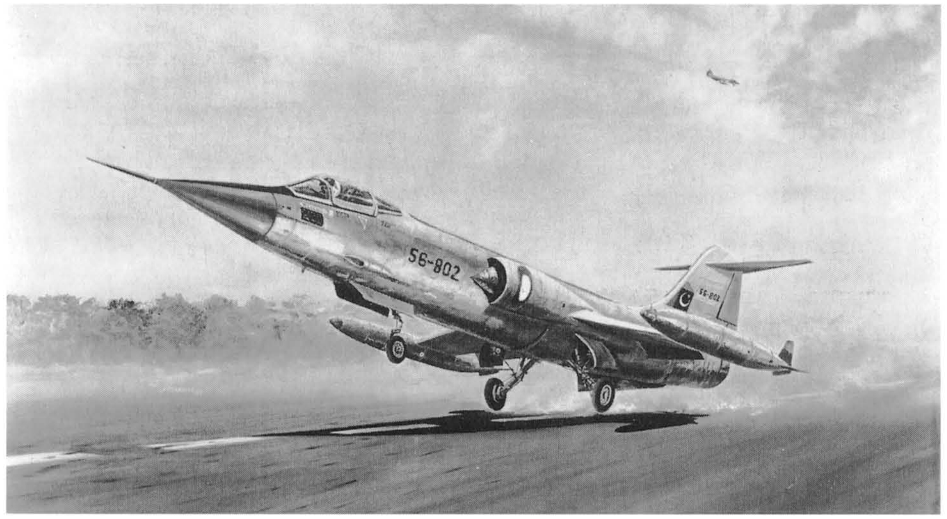
On 3 September, before the war began, a single PAF F-104A, flown by Flt Lt Hakimullah, was vectored at supersonic speed to intercept an IAF Gnat, whose pilot, Sqn Ldr Brijpal Singh Sikand, promptly lowered his undercarriage in surrender and landed at the abandoned PAF airfield of Pasrur. Sikand was made a PoW. Three days later, two Starfighters from Sargodha, with Flt Lt Aftab Alam Kahn, leading, and Flt Lt Amjad Hussain Khan as his wingman, were vectored by Sakesar Radar towards four IAF Mystères engaged in bombing and rocket attacks against a stationary passenger train at Gakkhar railway station near to the border with Kashmir. Flt Lt Aftab Alam Kahn recalls:

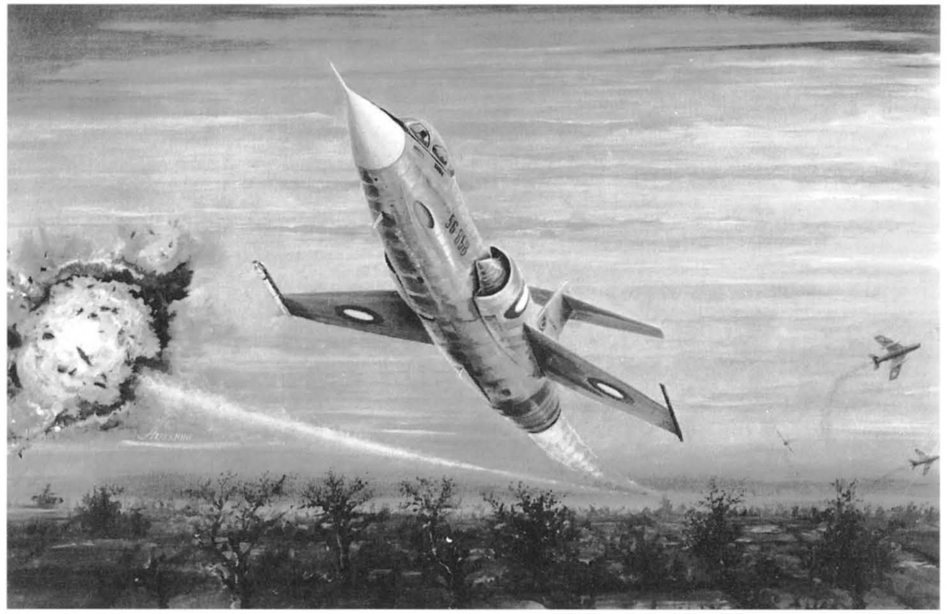
> I was informed that the IAF had crossed the Pakistan border and were attacking ground positions approximately 80 nautical miles south of us. This meant that India had actually decided to start an all-out war. We were immediately vectored and were soon over the site where the Indian aircraft were attacking. While dawn was breaking at 15,000ft, it was still dark down below. I asked for permission to descend to ground level, but was denied. The reason given was that radio contact would be lost. I, however, decided to descend and leaving my wingman at 15,000ft to act as radio relay, I dived down and headed towards some flashes.
>
> As I reached the area, I was surprised to see that I was flying head-on into a formation of four IAF Mystère IVA aircraft that were attacking ground targets I was shocked more than I was surprised, as I felt a wave of anger leap through me. I had to shoot down these aircraft. I jettisoned my external fuel tanks and started to engage the Mystères as they turned into me. Manoeuvring started at tree-top level. I kept my eyes 'glued' on the target. I could feel the strain under high 'G's', looking over the tail of the aircraft, keeping the enemy in sight, and skimming the trees at high speed. One mistake and I would have hit the ground. If I had lost sight of the Mystères the fight would have been over. The F-104, with the afterburner blazing, at low altitude, was responding very well. I used the high speed take-off flaps to improve the turning capability as required. The 'stick shaker' was a

**PAF Starfighters**

| *Serial* | *Model* | *US Serial No* | *Date Received* |
|---|---|---|---|
| 1 | F-104A | 56-802 | 5 August 1961 |
| 2 | F-104A | 56-803 | 5 August 1961 |
| 3 | F-104A | 56-804 | 5 August 1961 |
| 4 | F-104A | 56-805 | 5 August 1961 |
| 5 | F-104A | 56-807 | 5 August 1961 |
| 6 | F-104A | 56-868 | 5 August 1961 |
| 7 | F-104A | 56-874 | 5 August 1961 |
| 8 | F-104A | 56-875 | 5 August 1961 |
| 9 | F-104A | 56-877 | 5 August 1961 |
| 10 | F-104A | 56-879 | 5 August 1961 |
| 11 | F-104A | 56-773 | 8 June 1964 |
| 12 | F-104A | 56-798 | 1 March 1965 |
| 13 | F-104B | 57-1309 | 5 August 1961 |
| 14 | F-104B | 57-1312 | 5 August 1961 |

**Sqn Ldr Mian Sadruddin (first commander of No.9 Starfighter Air Superiority Squadron, PAF), followed by Sqn Ldr Mervyn Leslie Middlecoat, lands Pakistan's first Starfighter, F-104A 56-802, at Sargodha airfield in 1962.** PAF artist Hussaini





**The first Starfighter encounter with the Indian Air Force in the Indo-Pak war of September 1965, when at 0525 hours, 6 September, Flt Lt Aftab A. Khan destroyed an IAF Mystère IVA of No.1 Squadron IAF and damaged another. The engagement marked a new era of dogfighting at very low altitude. It was the first combat kill by any Mach 2 aircraft, and the first missile kill for the PAF.** PAF artist Hussaini

> big help in flying the aircraft to its limit. The Mystères would have no problem keeping the F-104 in sight because of its afterburner.
>
> After some hectic manoeuvring, I was positioned behind two aircraft, but the other two were still not visible. I then spotted them, further ahead. Joy leapt through me. I armed my weapons and decided to shoot the first two with missiles and the next two with guns. I fully realized that a confidential order prohibited me from using the missile below 10,000ft. However, I was sure the missile could be used effectively at any height provided the targets could be discriminated from the background heat sources. A distant increase in missile tone ensured this. I set the wingspan of the Mystère IVA, and started to recall the missile-firing checklist. 'Check Ranger, Check Tone, Check G's, Squeeze the trigger and hold.'
>
> I aimed the missile at the nearest aircraft, and heard the loud pitched missile tone. The sight indicated that I was in range. With all the other requisite firing conditions met, I squeezed the trigger, and kept it pressed. I waited, only to note that the missile had not fired. As I looked towards the left missile, I saw a big flash, and the missile leaving the aircraft. The missile had taken, as stipulated in the manual, approximately 8/10ths of a second to fire after the trigger had been pressed but in combat, this seemed like an eternity. The flash of the missile blinded me for a few seconds. The radar controller who was also monitoring the radio of the Mystères, immediately informed me that one Mystère had been shot down and that another had been damaged. I was then at once instructed to turn right and pick up visual contact with the other Mystères, which were exiting. I turned as directed but could not see them. On landing back, I was informed that the dogfight had taken place overhead the Rahwali airfield where a low-powered radar was located. The Mystère wreckage had fallen close by. The other three had gotten away.

This was the first combat kill by a Mach 2 aircraft and the first missile kill for the PAL. It was also proven that the F-104 and the Sidewinder missile was an effective weapon system at low altitude.

### *The Battle of Sargodha*

At around 05.15hrs on the morning of 7 September a large number of PAF F-104s and F-86s flew CAP in the vicinity of Sargodha waiting for the IAF to attack. The F-104s were assigned the outer perimeter, while the F-86s were kept closer to the airfield. The first IAF attack, at 0530, by six Mystère IVAs of No.1 Squadron, got through without being intercepted. Six Hawker Hunter F56s of Nos.7 and 27 Squadrons, IAF, carried out the second attack on Sargodha, at 0610 hours. The third attack was made at 0947 hours, by four Mystères of No.1 Squadron IAF, and a fourth and final attack on Sargodha was carried out by two Mystères at 1030 hours.

In one of the early attacks, Flt Lt Arif Iqbal in a F-104, was about to fire at a Mystère, when he suddenly saw a PAF F-86 flight appear between him and the IAF aircraft and shoot down the Mystère. Flt Lt Amjad Hussain Khan, who had missed his chance the day before, made amends. He made visual contact with the IAF Mystères and headed toward them. By the time he caught up with them, the Indian aircraft were 6–8 miles away from Sargodha, flying at 150–200ft in a south-easterly direction towards India.

As the Mystères jettisoned their drop tanks, Khan positioned himself behind one of them and released a Sidewinder missile, which went straight into the ground. The Mystère then began to dogfight with the Starfighter, which used its superior climb and acceleration to raise the combat from ground level to about 7,000ft to gain room for manoeuvre. Khan fired his cannon and was delighted to see the shells hit the Mystère. The IAF pilot Sqn Ldr A.B. Devayya[22] showed commendable courage in staying with the F-104, and despite being mortally wounded, scored several cannon strikes on the Starfighter. Hussain Khan managed to eject safely and reached his base. This was the only Starfighter to be lost through enemy action in the 1965 war.

Flt Lt Aftab Alam Khan continues:

> The pilots of No.9 Squadron competed fiercely, to undertake as many combat missions as they could, never missing a chance to close with the enemy looking for combat. In the days that followed, the F-104 pilots noted that whenever they got airborne, the IAF grounded all its aircraft. This made it very difficult for the F-104 pilots to engage the enemy during the day. Flt Lt Muchtaq, my brother, flying an F-104 in the same squadron, made contact with the enemy, only to note that as he approached the target, the IAF Hunters disengaged well in time. Flt Lt 'Mickey' Abbas in an F-104 had a similar episode. This experience would be repeated for the F-104 pilots for all daytime interceptions. I personally patrolled in a lone F-104, at 30,000ft, deep inside Indian territory, over the two Indian fighter airfields of Adamput and Halwara for one hour and there was no response from the Indian side. This was total air superiority, and it displayed the supremacy of the Starfighter.

> At medium and high altitudes the F-104 ruled the sky. The IAF refused to challenge the Starfighter. But below 5,000ft a fierce battle raged between the F-86 and the IAF fighters, mainly the Hunters and Gnats. The F-86 was the workhorse of the PAF. It was under-powered, outnumbered and outgunned. Nevertheless, the F-86 pilots showed great courage as they fearlessly engaged their opponents and displayed an unusual skill for air combat, achieving an excellent kill ratio. The F-104, by controlling the sky at medium and high altitude, had reduced the workload for the F-86s to the extent that the numbers were manageable. The F-8s could now hold their own against the enemy at low altitude.

**Flt Lt Aftab Alam Khan and Sqn Ldr Mervyn Middlecoat flying inverted in F-104B 57-1309 on a reconnaissance mission over the Indian airfield at Halwara on 9 September 1965.** PAF artist Hussaini

**Wg Cdr Arif Iqbal and Sqn Ldr Amanullah carrying out a surprise attack on the IAF airbase at Utterlai on 11 September 1965. During the 1971 Indo-Pak War, Arif Iqbal destroyed an Alizé aircraft of No. 310 squadron of the Indian Navy.** PAF artist Hussaini

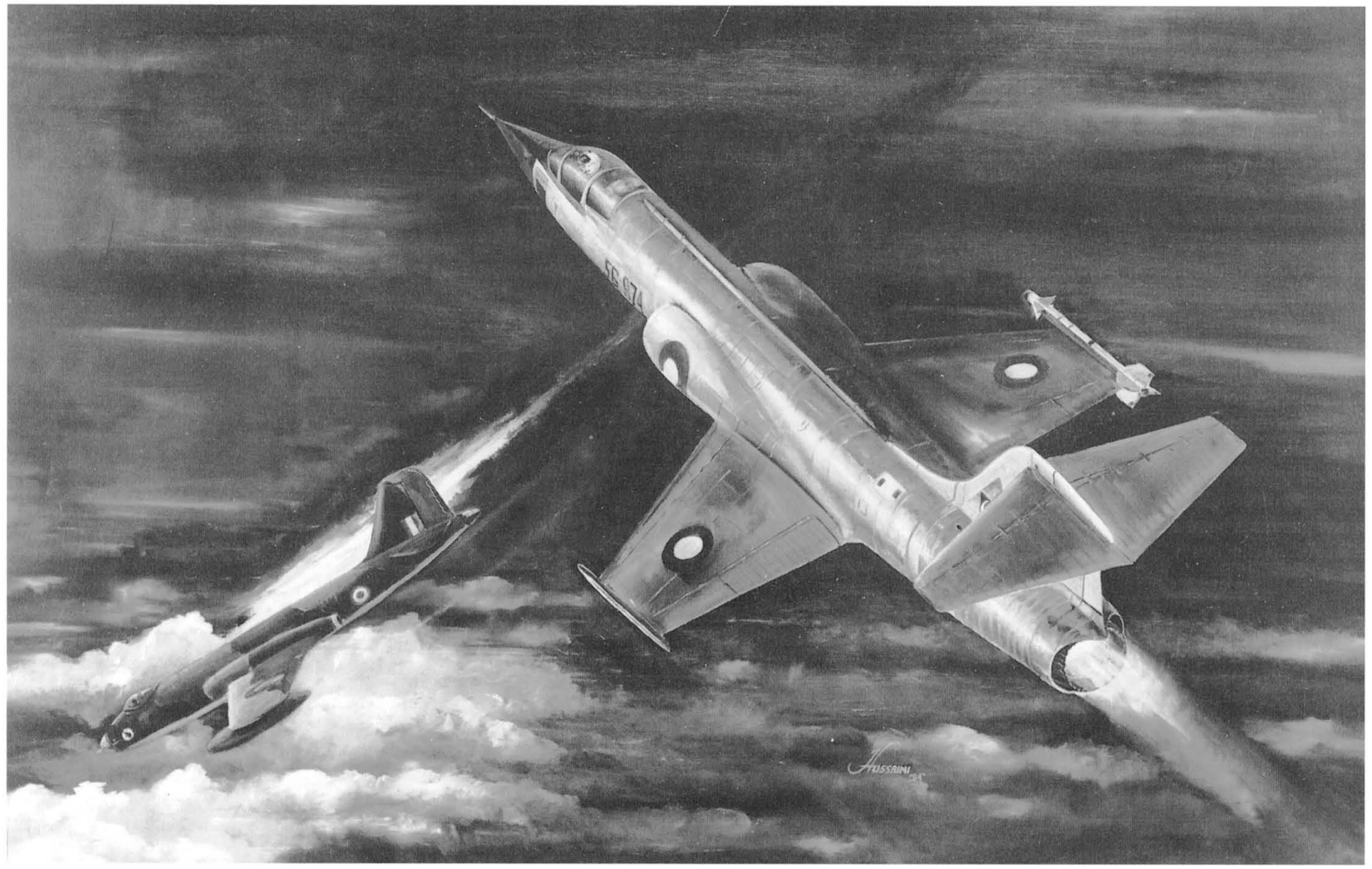
### *Reconnaissance*

Flt Lt Aftab Alam Khan continues:

> Immediately after the start of the war there was an urgent need for a high-speed reconnaissance aircraft. The PAF RT-33 was rendered obsolete with a speed of less than 400kt. It was liable to be shot down as it crossed the border. At night we did standby duties, one hour in the cockpit and one hour off. In the off time I would go and receive the B-57 pilots returning from their bombing missions over Indian airfields. The battle damage from these missions needed to be assessed. I suggested to the Base Commander that if he authorized a recce mission by the F-104, I would have a photograph on his table by noon next day. He ordered the mission.
>
> Low flying was not a part of the F-104 war plan – no training had been conducted – but while demonstrating the aircraft, I noticed that the Starfighter flew very well at low level. I planned the mission at 600kt (10mi/min). Low flying was normally done at 420kt in the F-86 squadrons. For the photograph I went to town early morning, and bought a film for my personal Yashica 120 camera. I then requested Sqn Ldr Middlecoat, the squadron commander, if he would allow me to fly while he took the pictures. He agreed.
>
> The mission was flown in a F-104B dual seater [57-1309]. Ten miles a minute made the DR navigation very easy. Over flat terrain, the height of the aircraft was lowered until Sqn Ldr Middlecoat said that downwash was hitting the ground. This height was then maintained – a thrilling experience. We pulled up, slightly offset from the airfield. Pictures were taken and a visual recce made. The photographs were placed on the Base Commander's table, as promised. The missions that followed were with bigger and better cameras but I was always told to fly. The F-104 had a new role.

### *Night Interception*

During the 1965 war, the F-104s flew a total of 246hr 45min. Mostly, the missions flown were Air Defence and Air Superiority operations, but forty-two were at night against IAF Canberra B(I)58s. The Starfighter's rudimentary AN/ASG-14T1 fire-control radar system met the Soviet high altitude bomber threat of the Cold War era for which it was designed, but it could not illuminate small targets against ground clutter. The standard high-speed intercept tactic employed by PAF's F-104 pilots was to approach their targets from below, with a typical height differential of 2,000–3,000ft



**The end of a night intruder. On the night of 21 September 1965 Sqn Ldr Jamal A. Khan, flying F-104A 56-874, intercepted an Indian Air Force Canberra B(I)58 at about 33,000ft (10,000m) and shot it down with a Sidewinder AAM near Fazilka, inside Pakistani territory. It was the only night missile kill for the PAF F-104.** PAF artist Hussaini

(610m–910m), against a target they wished to acquire at a range of 10–15km.

This limitation was well known to the Canberra jet bomber pilots of the IAF, who attacked targets in Pakistan during the 1965 war. They adopted a standard hi-lo-hi profile to minimize the threat of interception. During most of their inbound and outbound flight over Pakistani territory the IAF Canberra B(I)58s of Nos. 5 and 35 squadrons would stay below about 1,000ft (300m) during their approach and exit phases. This posed a difficult night interception problem. The PAF F-104s had, in these circumstances, to be used in an unconventional low-altitude intercept profile that severely challenged the capabilities of its airborne radar. To pick up low-flying bombers on their scope, the F-104 pilots had to get down to about 300–500ft (90m–150m) AGL to point their radars upward and clear of the ground clutter at the IAF bombers. The problem was exacerbated by the Canberra's tail warning audible alarm that would go off the moment an F-104 got to near astern position and enable the bomber to take timely evasive action to shake off its pursuer.

On 21 September, Sqn Ldr (later ACM) Jamal A. Khan, flying F-104A 56-874, intercepted an IAF Canberra B(I)58 at about 33,000ft (10,050m). He executed a perfect 'textbook' attack and shot it down with a Sidewinder near Fazilka, inside Pakistani territory. The bomber pilot, Flt Lt Manmohan Lowe, ejected and was made a PoW, while the navigator, Flying Officer A.K. Kapor, who could not eject, was killed in the action. (The British-built Canberra B(I)58, unlike its American counterpart, the Martin B-57, which the PAF used, had no ejection seat for the navigator). This was the first kill achieved by an F-104 at night after a number of near misses due to factors described earlier.

Flt Lt Aftab Alam Khan adds:

> As the war progressed, a radar controller assigned to the army gun radar unit told me that the army radar could see the IAF Canberras very clearly at night, but the track length was limited to approximately 20 nautical miles. I realized that this was good enough for the F-104 to make an interception. With its high speed it could position behind the target very fast. Once this was done, the F-104 could be aligned with the help of its InfraRed (IR) gunsight for a missile or a gun attack. The Canberra tail warning radar was ineffective at low altitude. To get the system working only a radio had to be installed in the army radar unit. The war ended before the system was made effective and put into practice.
>
> Flying the high speed F-104 at night in wartime conditions was hazardous. The environment was as hostile and dangerous as the enemy. When there was no moon, the nights were pitch dark, as the blackout was complete. Haze and poor visibility was common.
>
> The runway lights were switched on once the aircraft was about to pitch out for a landing. We were lucky if we could see the airfield lights on downward, and turning base. The landing conditions were severe. The TACANs were not aligned with the runways. There were no approach lights, ILS or VASI. It was under these conditions that Flt Lt Abbasi, while making an approach, crashed short of the runway. The F-104 was destroyed, but miraculously, he escaped and survived to fly again.
>
> A cease-fire had been agreed to and the fighting was to stop at 3 am on 23 September 1965. I was told to confirm the same from the air. The visibility was excellent but it was like a dark night. From 30,000ft I could see the firing along the bomb-line. It looked like a ping pong match. Exactly at 3am the firing started to slow down and then it stopped completely. I made the report and was ordered to land back at the home base. As I came on final approach, I noticed the runway was tilted to the left. I turned left and I was no longer aligned with the runway. I approached in a zig-zag manner and decided to go-around and try again. I guess the stress, fatigue and landing conditions were creating illusions.
>
> I asked for my squadron commander, who came immediately. I explained the problem, and he gave me the necessary instructions. The next approach was worse, after which I had fuel left for two attempts. I tried again and I was told to overshoot. My squadron commander then told me to eject on the downwind. He was getting the helicopter airborne. Now, I had only 200lb of fuel left, just enough for one last approach. At this time the air traffic controller requested permission to switch on the entire airfield lights, as the war was over. As soon as this was done, my senses returned to normal and a safe landing was carried out. Thus ended the 1965 Indo-Pak War. The F-104 and myself had seen the start, and we saw the finish; a lucky and historic coincidence.
>
> Pakistan got the better of the IAF, with odds of 1:6 or 150:900. Air superiority was maintained day and night. The genius and courage of AM Nur Khan and F-104/F-86 team had made this possible. Undoubtedly, the F-86 was the workhorse, but the F-104 had a very special task. The PAF pilot/F-104 team had created a situation where the IAF pilots did not have the will to fight the F-104. When the F-104 was 'up', the IAF was 'Down on the Ground'. This removed a major portion of the threat. The Starfighter and its pilots had contributed immensely to achieving this victory. The pilots fought very aggressively, never losing an opportunity to engage the enemy by day or night. Working long hours, and flying under difficult flight conditions, the maintenance crews and the F-104s deserve a special accolade: not one technical abort, or snag affected a mission!
>
> The F-104 was flown by determined pilots, maintained by efficient crew and supported by dedicated radar controllers. This made a tremendous team, that helped win the battle for air superiority for the PAF. The F-104 Starfighter was in a 'class of its own'. 'Superlative' to say the least. Without the dozen Starfighters the outcome of the war may not have been so good. It definitely was a pleasure, a thrill, and the ultimate experience to fly the F-104 in combat.'
>
> Six F-104 pilots received gallantry awards during the 1965 war.

### *The Indo-Pakistan War of 1971*

On Friday 3 December (the Moslem sabbath) 1971, India and Pakistan went to war with each other once again. In an attempt to emulate the Israeli pre-emptive strike at the start of the Arab–Israeli war of 1967, air operations this time commenced with a pre-emptive strike by the PAF at around dusk. However, the IAF admitted to losing just three aircraft, and the onset of night prevented any further advantage the attackers may have had.

The F-104 was used for deep penetration strikes against IAF airfields and radars. Two F-104s attacked Amritsar and Faridkot IAF radars. The attack on Faridkot was led by Wg Cdr Arif Iqbal, who not only damaged the radar but also shot down an IAF Krishak aircraft.

On 4 December Sqn Ldrs Amanullah and Rashid Bhatti attacked Amritsar radar. They met with stiff resistance but managed to shoot down two aircraft, an IAF Gnat, and a Sukhoi Su-7 *Fitter*. The pilot of the Gnat, Flt Lt J. Preira, was killed. Four days later, Flt Lt Manzoor Bokhari intercepted an IAF Canberra B(I)58 and shot it down during a low-level chase. On 10 December, Wing Commander Arif Iqbal, while attacking the Indian harbour at Okha, shot down a Breguet Alizé ASW aircraft of the Indian Navy (one of twelve supplied for No.310 Squadron aboard the carrier *Vikrant*) into the sea. Its crew members, Lt Cdr Ashok Roy, Lt H.S. Sirohi, and AC O. Vijayan, were all killed.

On 12 December the PAF became the only nation to use the Starfighter in air-to-air combat, when two F-104s flying at low level towards Indian airfields or port installations bordering the Gulf of Kutch were intercepted by two MiG-21FLs from Jamnagar. One of the F-104As broke off and disengaged. The other Starfighter, which was flown by Wg Cdr Middlecoat, one of the veterans of the 1965 War, was pursued over the Gulf by one of the MiG-21s, flown by Flt Lt Bharat B. Soni, who destroyed Middlecoat's Starfighter. Flt Lt Arun K. Dutta, another MiG-21 pilot, was awarded the claim of having shot down Flt Lt Samad Changezi. Both Wg Cdr Middlecoat and Flt Lt Samad Changezi were awarded the *Sitara-e-Jrat* (approximately equivalent to the British Distinguished Flying Cross).

Although the PAF scored a three-to-one kill ratio, destroying 102 IAF aircraft and losing 34 aircraft of its own, the war was only three days old when East Pakistan fell. After just thirteen days, on 16 December, the war between India and Pakistan ended when Pakistan agreed to Indian demands for an unconditional surrender. The Indian victory was achieved with significant help from its ally the Soviet Union. Although there was a US Government embargo on arms sales to both India and Pakistan (which had been in force ever since the 1965 war began), no consideration was given to the fact that India, a long-time ally of the soviet Union, barely used any American military equipment and the sanctions exclusively degraded the combat potential of only the Pakistani armed forces. At least one Tupolev Tu-126 'Moss' AWACS (Airborne Warning and Control System) aircraft, which would effectively have observed every move the PAF made or intended to make, was detached, with its crew, to serve with the IAF during the 1971 war. Indian ECM effectively knocked out the Pakistani ground radar and communications network.

The PAF F-104 inventory was particularly hard hit by the arms embargoes. Eventually it became impossible to maintain a reasonable in-commission rate on the F-104A/Bs and the PAF decided to phase it out of service late in 1972. Thus ended the era of Pakistan Air Force's first Mach 2 combat aircraft.

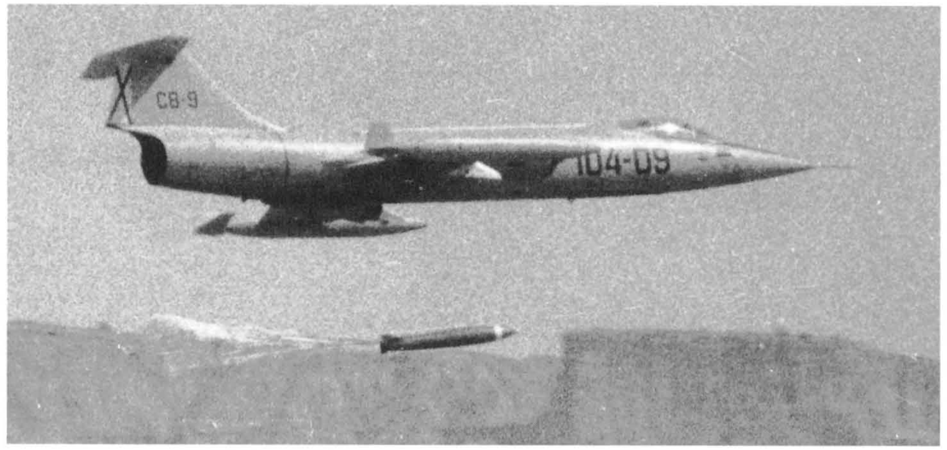
## Spain

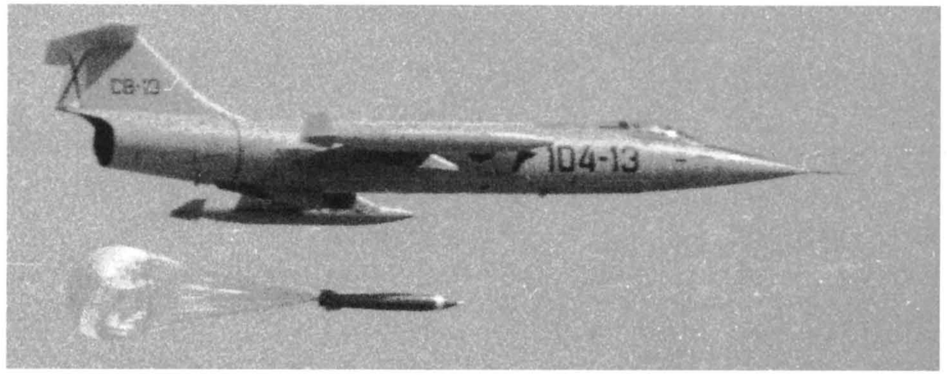
Under the terms of the Military Assistance Program (MAP), Spain received eighteen C.8 and three CE.8 Starfighters (Canadair-built F-104Gs and Lockheed TF-104Gs respectively). These served with a single squadron in the *Ejercito del Aire* (Spanish Air Force) which operated these aircraft at Torrejón between February 1965 and 31 May 1972. As *61 Escuadrón (Ala no.6)*, the

F-104s were operated from February to April 1965, when the unit was renumbered *161 Escuadrón (Ala no 16)*. On 29 November 1967 the unit was renumbered *104 Escuadrón (Independient)*, and operated as such until 27 May 1971, when it became *104 Escuadrón (Ala no.12)* (for just five days) then finally, *122 Escuadrón (Ala no.12)*. The F-104G/TF-104Gs were replaced in service by two squadrons of the F-4C Phantom II and in 1972 the Spanish Starfighters were returned to the USAF for transfer to Greece and Turkey. In 1972 eight F-104Gs and two RF-104Gs were transferred to Turkey, while Greece received nine F-104Gs and one TF-104G previously operated by the *Ejercito del Aire*.

Spain was unique among the European operators of the Starfighter since it never lost an aircraft during their 17,060.35 hours of operational use. Spain joined NATO in 1982.

***(Above)* Eighteen C.8 and three CE.8 Starfighters (Canadair-built F-104Gs and Lockheed TF-104Gs respectively) served with the** Ejercito del Aire **(Spanish Air Force), March 1965–May 1972. These C.8 Starfighters – 62-12733, 62-12716, 62-12715 and 62-12720 – are from** 161 Escuadrón (Ala n°.16), **which operated these aircraft at Torrejón from April 1965 until 29 November 1967, when the unit was renumbered** 104 Escuadrón (Independiente/Ala n°.12). **Spain joined NATO in 1982.** Lockheed





***(Top)* C8-9 of** 104 Escuadrón (Independiente/Ala n°.12) **dropping a retarded bomb.** via Philip Jarrett

***(Bottom)* C8-13 of** 104 Escuadrón (Independiente/Ala n°.12) **dropping a retarded bomb.** 104 Escuadrón **was renumbered** 122 Escuadrón (Independiente/Ala n°.12) **on 31 May 1971. In May 1972 all twenty-one Spanish Starfighters were returned to the USAF for transfer to Greece (ten) and Turkey (eleven).** via Philip Jarrett

## Taiwan

Altogether, the Republic of China Air Force (RoCAF) of Taiwan received a total of 281 Starfighters: forty-six F-104As; eight F-104Bs; six F-104Ds; 115 F-104Gs (including thirty-seven from the *Luftwaffe*, fourteen from Belgium (used for spare parts), and three from Turkey); forty-nine TF-104Gs (including twenty-seven ex-*Luftwaffe* machines following the closure of its Starfighter training facility at Luke AFB, Arizona, nine ex-*BLu* two-seaters (used for spare parts), and three ex-*KDF* two-seaters); twenty-five RF-104Gs (including three ex-*Luftwaffe* aircraft); and twenty-seven ex-JASDF F-104Js and five F-104DJs under the 'ALISAN 9' project in 1978 (five of the F-104Js were used for spare parts).

The first two Starfighters – F-104B-5-LOs 57-1294 and 57-1300 – were delivered in May 1960 and were serialled 4101 and 4102 respectively. Between August and September that year seven F-104As were received and in October, two more F-104B-5-LOs (57-1298 and 1299) were delivered. (A fifth F-104B, 57-1296, was delivered in October 1963 as an attrition replacement – four F-104As and two F-104Bs being lost in crashes 5 May 1961–10 October 1964, and eight pilots killed.) A further batch of fifteen F-104As was delivered between late November 1960 and early January 1961. All these Starfighters were used to equip No.8 Squadron as part of the 3rd Tactical Fighter Wing at Ching Chuang Kang (CCK) Air Base in central Taiwan.

**Ex-**Luftwaffe **TF-104G 4178 (61-3082) which operated with the RoCAF (Republic of China Air Force).** Ton van der Zeeuw

***(Below)* Ex-**Luftwaffe **TF-104G (61-3083) 4179, which also operated with the RoCAF (Republic of China Air Force).** Ton van der Zeeuw

During 1961, 1962 and 1964 a number of F/TF/RF-104Gs, fitted with Martin-Baker GQ7A ejection seats, were ordered. The first Canadair built Starfighter for the RoCAF (63-12728) first flew on 7 October 1964 and was given the serial 4333. The Gs were used to re-equip No.8 Squadron at CCK and also to replace the Sabres of Nos. 7 and 28 Squadrons.

On 13 January 1967 twelve MiG-19s of the Chinese Air Force of the People's Liberation Army (AF/PLA fought with four F-104Gs of the RoCAF (4344, 4348, 4353, and 4355) over the disputed island of Quemoy. One MiG-19 was claimed by Shin-Lin Hu flying F-104G 4344. 4353 was lost.

President Nixon's visit to mainland China in 1978 resulted in much closer ties with the United States while the introduction of more modern aircraft to Taiwan was delayed for fear of upsetting the Communist regime. As a result, Taiwan broke off diplomatic relations with the US and it was forced to source its Starfighters from further afield. They came not just from NATO nations, but also from Japan, and Taiwan was able to replace its ageing F-100A Super Sabres with, albeit, somewhat 'weary' Starfighter aircraft. The 'new' F-104s replaced the F-100As in No.41 Squadron of the 2nd Tactical Fighter Wing at Hsinchu, and Starfighters were also issued to Nos. 42 and 48 Squadrons, and to Nos. 7, 8 and 28 Squadrons of the 3rd TFW. Four of the ex-JASDF Starfighters were lost, including one while en route from the overhaul facility at Ping Tung South to CCK. On 5 December 1990 the commander of the RoCAF was killed when 4511 reportedly disintegrated during flight.

At the end of 1986, Starfighters still equipped three interceptor/strike squadrons and one reconnaissance squadron. By early 1994 the surviving Starfighters were operational with the 41st, 42nd and 48th Tactical Fighter Squadrons of the 499th Tactical Fighter Wing at Hsinchu (with F-104Gs); the 7th, 8th and 35th TFSs of the 427th Tactical Fighter Wing (F-104G) and the 28th, a training unit (with a mix of TF-104Gs and F-104Gs), at Ching Chaung Kang (CCK) Air Base; and the 12th (Reconnaissance) Squadron (operating as part of the 6th TRG with RF-104Gs) of the 401st Tactical Composite Wing (largely equipped with the F-5E Tiger II), at Taoyuan. During 1996–97 all remaining Starfighter units were either re-equipped with the General Dynamics F-16A/B Fighting Falcon or the Dassault Mirage 2000-5.

**TF-104G (66-13622), another ex-**Luftwaffe **Starfighter, which became 4195 of the RoCAF (Republic of China Air Force).** Ton van der Zeeuw

### Starfighters of the Republic of China Nationalist Air Force (Taiwan)

| *Serial* | *Type* | *Taiwan Ser* | *Notes* |
|---|---|---|---|
| 57-1294 | F-104B | 4101 | op. 17.5.60–19.10.66. To Jordan |
| 57-1300 | F-104B | 4102 | op 10.5.60–5.5.61 |
| 57-1298 | F-104B | 4103 | op. 17.10.60–10.66. To Jordan |
| 57-1299 | F-104B | 4104 | op. 19.10.60–crashed 3 March 1962 |
| 57-1296 | F-104B | 4105 | op. 17.10.60–10.66. To Jordan |
| 57-1310 | F-104B | 4121 | op. 28.7.70–crashed 27 June 1984 |
| 56-3723 | F-104B | 4122 | op. 28.7.70–crashed 8 May 1971 |
| 56-3722 | F-104B | 4123 | op. 3.5.72–wfu 1988 |
| 57-1315 | F-104D | 4161 | op. 30.7.75–wfu 1988 |
| 57-1316 | F-104D | 4162 | op. 30.7.75–wfu 1988 |
| 57-1318 | F-104D | 4163 | op. 30.7.75–wfu 1988 |
| 57-1319 | F-104D | 4164 | op. 30.7.75–wfu 1988 |
| 57-1321 | F-104D | 4165 | op. 30.7.75–wfu 1988 |
| 57-1326 | F-104D | 4166 | op. 30.7.75–wfu 1988 to RoCAF Historial Museum |
| 62-12262 | TF-104G | 4141 | op. 8.12.63 |
| 62-12265 | TF-104G | 4142 | op. 8.12.63–crashed 12.6.73 |
| 62-12268 | TF-104G | 4143 | op. 20.1.64–crashed 25.12.67 |
| 62-12269 | TF-104G | 4144 | op. 20.1.64–crashed 10.12.73 |
| 62-12270 | TF-104G | 4145 | op. 20.1.64–crashed 10.6.70 |
| 62-12271 | TF-104G | 4146 | op. 20.1.64–crashed 25.5.82 |
| 61-3030 | TF-104G | 4147 | op. 20.5.68–wfu |
| 61-3025 | TF-104G | 4148 | op. 1.67–wfu |
| 61-3026 | TF-104G | 4149 | op. 4.6.68–1996 |
| 61-3029 | TF-104G | 4150 | op. 1969–1996 |
| 63-12682 | TF-104G | 4151 | ex-Royal Danish Air Force. op. 30.3.87–wfu |
| 63-12683 | TF-104G | 4152 | ex-Royal Danish Air Force. op. 31.3.87–wfu |
| 63-12684 | TF-104G | 4153 | ex-Royal Danish Air Force. op 2.3.87–wfu |
| 61-3073 | TF-104G | 4171 | ex-*Luftwaffe* op. 1983–wfu |
| 61-3074 | TF-104G | 4172 | ex-*Luftwaffe* op. 1983–wfu |
| 61-3075 | TF-104G | 4173 | ex-*Luftwaffe* op. 1983–wfu |
| 61-3076 | TF-104G | 4174 | ex-*Luftwaffe* op. 1983–wfu |
| 61-3078 | TF-104G | 4175 | ex-*Luftwaffe* op. 1983–crashed 23.5.89 |
| 61-3079 | TF-104G | 4176 | ex-*Luftwaffe* op. 1983–wfu |
| 61-3080 | TF-104G | 4177 | ex-*Luftwaffe* op. 1983–wfu |
| 61-3082 | TF-104G | 4178 | ex-*Luftwaffe* op. 1983–wfu |
| 61-3083 | TF-104G | 4179 | ex-*Luftwaffe* op. 1983–wfu |
| 61-3084 | TF-104G | 4180 | ex-*Luftwaffe* op. 1983–crashed 23.3.88 |
| 63-8452 | TF-104G | 4181 | ex-*Luftwaffe* op. 1983–wfu |
| 63-8454 | TF-104G | 4182 | ex-*Luftwaffe* op. 1983–wfu |
| 63-8455 | TF-104G | 4183 | ex-*Luftwaffe* op. 1983–crashed |
| 63-8456 | TF-104G | 4184 | ex-*Luftwaffe* op. 1983–crashed 11.8.96 |
| 63-8457 | TF-104G | 4185 | ex-*Luftwaffe* op. 1983–crashed 7.9.91 |
| 63-8458 | TF-104G | 4186 | ex-*Luftwaffe* op. 1983–wfu |
| 63-8460 | TF-104G | 4187 | ex-*Luftwaffe* op. 1983–wfu |
| 63-8461 | TF-104G | 4188 | ex-*Luftwaffe* op. 1983–wfu |
| 63-8462 | TF-104G | 4189 | ex-*Luftwaffe* op. 1983–wfu |
| 63-8463 | TF-104G | 4190 | ex-*Luftwaffe* op. 1983–wfu |
| 63-8464 | TF-104G | 4191 | ex-*Luftwaffe* op. 1983–crashed 4.9.87 |
| 63-8465 | TF-104G | 4192 | ex-*Luftwaffe* op. 1983–wfu |
| 63-8467 | TF-104G | 4193 | ex-*Luftwaffe* op. 1983–wfu |
| 63-8468 | TF-104G | 4194 | ex-*Luftwaffe* op. 1983–wfu |
| 66-13622 | TF-104G | 4195 | ex-*Luftwaffe* op. 1983–wfu |
| 66-13625 | TF-104G | 4196 | ex-*Luftwaffe* op. 1983–wfu |
| 66-13631 | TF-104G | 4197 | ex-*Luftwaffe* op. 1983–wfu |
| 56-0839 | F-104A | 4201 | op. 11.8.60–19.10.66. To Jordan |
| 56-0828 | F-104A | 4202 | op. 11.8.60–crashed 12.7.62 |
| 56-0850 | F-104A | 4203 | op. 11.8.60–17.10.66. To Jordan |
| 56-0845 | F-104A | 4204 | op. 11.8.60–20.10.66. To Jordan |
| 56-0842 | F-104A | 4205 | op. 11.8.60–crashed 10.10.64 |
| 56-0843 | F-104A | 4206 | op. 11.8.60–21.10.66. To Jordan |
| 56-0838 | F-104A | 4207 | op. 11.8.60–crashed 12.7.63 |

### Starfighters of the Republic of China Nationalist Air Force (Taiwan) *(continued)*

| *Serial* | *Type* | *Taiwan Serial* | *Notes* |
|---|---|---|---|
| 56-0769 | F-104A | 4208 | op. 22.11.60–crashed 18.12.63. |
| 56-0767 | F-104A | 4209 | op. 25.11.60–10.66. To Jordan |
| 56-0774 | F-104A | 4210 | op. 28.11.60–14.10.66. To Jordan |
| 56-0775 | F-104A | 4211 | op. 1.12.60–14.10.66. To Jordan |
| 56-0780 | F-104A | 4212 | op. 6.12.60–17.10.66. To Jordan |
| 56-0777 | F-104A | 4213 | op. 9.12.60–18.10.66. To Jordan |
| 56-0778 | F-104A | 4214 | op. 14.12.60–18.10.66. To Jordan |
| 56-0786 | F-104A | 4215 | op. 19.12.60–14.10.66. To Jordan |
| 56-0787 | F-104A | 4216 | op. 22.12.60–crashed 10.10.64. |
| 56-0788 | F-104A | 4217 | op. 29.12.60–20.10.66. To Jordan |
| 56-0789 | F-104A | 4218 | op. 4.1.61–17.10.66. To Jordan |
| 56-0798 | F-104A | 4219 | op. 9.1.61–10.64. To Pakistan |
| 56-0797 | F-104A | 4220 | op. 12.1.61–18.10.66. To Jordan |
| 56-0799 | F-104A | 4221 | op. 17.1.61–20.10.66. To Jordan |
| 56-0800 | F-104A | 4222 | op. 20.1.61–crashed 1.10.62 |
| 56-0837 | F-104A | 4223 | op. 21.7.61–crashed 12.7.62 |
| 56-0823 | F-104A | 4241 | op. 28.7.70–wfu 1988 |
| 56-0827 | F-104A | 4242 | op. 30.7.70–wfu 1988 |
| 56-0844 | F-104A | 4243 | op. 30.7.70–crashed 8.2.88 |
| 56-0854 | F-104A | 4244 | op. 28.7.70–wfu 1988 |
| 56-0858 | F-104A | 4245 | op. 28.7.70–wfu 1988 |
| 56-0861 | F-104A | 4246 | op. 30.7.70–wfu 1988 |
| 56-0866 | F-104A | 4247 | op. 30.7.70–crashed 11.4.81 |
| 56-0880 | F-104A | 4248 | op. 30.7.70–crashed 16.11.75 |
| 56-0808 | F-104A | 4249 | op. 7.8.70–wfu 1988 |
| 56-0816 | F-104A | 4250 | op. 4.8.70–wfu 1988 |
| 56-0822 | F-104A | 4251 | op. 4.8.70–wfu 1988 |
| 56-0831 | F-104A | 4252 | op. 20.8.70–wfu 1988 |
| 56-0833 | F-104A | 4253 | op. 20.8.70–wfu 1988 |
| 56-0846 | F-104A | 4254 | op. 20.8.70–wfu 1988 |
| 56-0856 | F-104A | 4255 | op. 4.8.70–wfu 1988 |
| 56-0867 | F-104A | 4256 | op. 20.8.70–wfu 1988 |
| 56-0870 | F-104A | 4257 | op. 20.8.70–crashed 24.5.77 |
| 56-0876 | F-104A | 4258 | op. 4.8.70–wfu 1988 |
| 56-0878 | F-104A | 4259 | op. 20.8.70–wfu 1988 |
| 56-0882 | F-104A | 4260 | op. 4.8.70–crashed 13.2.74 |
| 56-0829 | F-104A | 4261 | op. 12.10.72–crashed 1.11.75 |
| 56-0852 | F-104A | 4262 | op. 12.10.70–wfu 1988 |
| 56-0829 | F-104A | 4263 | op. 12.10.70–wfu 1988 |
| 62-12250 | RF-104G | 4301 | –wfu |
| 62-12251 | RF-104G | 4302 | –wfu |
| 62-12252 | RF-104G | 4303 | –wfu 10.88 |
| 62-12254 | RF-104G | 4304 | –wfu 15.10.87 |
| 62-12255 | RF-104G | 4305 | –wfu 18.4.74 |
| 62-12247 | RF-104G | 4306 | –wfu 6.8.96 |
| 62-12353 | RF-104G | 4307 | –wfu |
| 62-12256 | RF-104G | 4308 | –wfu 20.3.92 |
| 62-12258 | RF-104G | 4309 | –wfu 10.88 |
| 62-12260 | RF-104G | 4310 | –wfu |
| 62-12214 | F-104G | 4311 | –wfu 29.8.75 |
| 62-12215 | F-104G | 4312 | –crashed 1.6.92 |
| 62-12216 | F-104G | 4313 | –wfu 25.6.74 |
| 62-12217 | F-104G | 4314 | –25.6.74/wfu |
| 62-12218 | F-104G | 4315 | –16.9.68/wfu |
| 62-12219 | F-104G | 4316 | –5.5.66/wfu |
| 62-12257 | RF-104G | 4317 | –5.5.66/wfu |
| 62-12259 | RF-104G | 4318 | –5.5.66/wfu |
| 62-12261 | RF-104G | 4319 | –9.12.89/wfu |
| 62-12220 | F-104G | 4320 | –9.12.89/wfu |
| 62-12221 | F-104G | 4321 | –9.12.89/wfu |
| 62-12222 | F-104G | 4322 | –9.12.89/wfu |
| 62-12223 | F-104G | 4323 | –9.12.89/wfu |
| 62-12224 | F-104G | 4324 | –9.12.89/wfu |
| 62-12225 | F-104G | 4325 | –19.4.67/wfu |
| 62-12226 | F-104G | 4326 | –19.4.67/wfu |
| 62-12227 | F-104G | 4327 | –24.11.65/wfu |
| 62-12228 | F-104G | 4328 | –20.7.65/wfu |
| 62-12229 | F-104G | 4329 | –crashed 28.10.65 |
| 62-12230 | F-104G | 4330 | –crashed 24.5.66 |
| 62-12231 | F-104G | 4331 | –24.5.66/wfu |
| 62-12238 | F-104G | 4332 | –24.5.66/wfu |
| 62-12728 | F-104G | 4333 | –20.11.71/wfu |
| 64-17760 | F-104G | 4334 | –25.7.76/wfu |
| 64-17761 | F-104G | 4335 | op. 1966–25.7.76 |
| 64-17762 | F-104G | 4336 | op. 1966–25.7.76/wfu |
| 64-17763 | F-104G | 4337 | –25.7.76/wfu |
| 64-17765 | F-104G | 4338 | first flew 23.2.65. Taiwan: 1966–25.7.76/wfu |
| 64-17766 | F-104G | 4339 | first flew 24.2.65. Taiwan: 1966–25.7.76/wfu |
| 64-17767 | F-104G | 4340 | first flew 2.3.65. Taiwan: 1966–25.7.76/wfu |
| 64-17768 | F-104G | 4341 | first flew 4.3.65. Taiwan: –25.7.76/wfu |
| 64-17764 | F-104G | 4342 | first flew 19.2.65. Taiwan: –crashed 24.7.84 |
| 64-17769 | F-104G | 4343 | first flew 3.3.65. Taiwan: 1966–crashed 17.2.81 |
| 64-17770 | F-104G | 4344 | first flew 15.3.65. To USAF 9.7.65. To Taiwan AF –6.8.96. Shih-Lin Hu believed to have shot down a MiG-19 in this F-104G, on 13.1.67 |
| 64-17771 | F-104G | 4345 | first flew 15.3.65. Taiwan: 1966–crashed 16.3.71 |
| 64-17772 | F-104G | 4346 | first flew 17.3.65. Taiwan: 1966–11.11.67 |
| 64-17773 | F-104G | 4347 | first flew 24.3.65. Taiwan: –11.11.67/wfu shot down a Chinese MiG-19 in 1960s |
| 64-17774 | F-104G | 4348 | first flew 13.5.65. Taiwan: –11.11.67/wfu |
| 64-17775 | F-104G | 4349 | first flew 2.4.65. Taiwan: –wfu 1996 |
| 64-17776 | F-104G | 4350 | first flew 30.3.65. Taiwan: –crashed 11.11.82 |
| 64-17777 | F-104G | 4351 | first flew 15.4.65. Taiwan: –11.11.82/wfu |
| 64-17778 | F-104G | 4352 | first flew 11.5.65. Taiwan: –11.11.82/wfu |
| 64-17779 | F-104G | 4353 | first flew 11.6.65. Taiwan: –shot down 13.1.67 |
| 64-17792 | F-104G | 4354 | op. 12.10.70–21.7.75 |
| 64-17793 | F-104G | 4355 | op. 12.10.70–20.10.74 |
| 64-17794 | F-104G | 4356 | op. 12.10.70–20.10.82 |
| 64-17795 | F-104G | 4357 | op. 12.10.70–20.10.82/wfu |
| 64-17786 | F-104G | 4358 | op. 12.10.70–20.10.82/wfu |
| 61-2604 | F-104G | 4359 | ex-Turkey. op. 12.10.70–6.83 |
| 61-2607 | F-104G | 4360 | ex-Turkey. op. 12.10.70–15.5.71 |
| 61-2608 | F-104G | 4361 | ex-Turkey. op. 12.10.70–11.2.76 |
| 63-13229 | F-104G | 4362 | ex-*Luftwaffe* op. 1983–wfu |
| 63-13234 | F-104G | 4363 | ex-*Luftwaffe* op. 1983–wfu |

**Starfighters of the Republic of China Nationalist Air Force (Taiwan)** *(continued)*

| *Serial* | *Type* | *Taiwan Ser* | *Notes* |
|---|---|---|---|
| 63-13235 | F-104G | 4364 | ex-*Luftwaffe* op. 1983–wfu |
| 63-13238 | F-104G | 4365 | ex-*Luftwaffe* op. 1983–1995 |
| 63-13240 | F-104G | 4366 | ex-*Luftwaffe* op. 1983–7.3.94 |
| 63-13242 | F-104G | 4367 | ex-*Luftwaffe* op. 1983–7.3.94 |
| 63-13243 | F-104G | 4368 | ex-*Luftwaffe* op. 1983–24.3.90 |
| 63-13244 | F-104G | 4369 | ex-*Luftwaffe* op. 1983–12.10.91 |
| 63-13245 | F-104G | 4370 | ex-*Luftwaffe* op. 1983–30.10.91 |
| 63-13249 | F-104G | 4371 | ex-*Luftwaffe* op. 1983–8.8.96 |
| 63-13251 | F-104G | 4372 | ex-*Luftwaffe* op. 1983–7.3.94 |
| 63-13252 | F-104G | 4373 | ex-*Luftwaffe* op. 1983–wfu |
| 63-13253 | F-104G | 4374 | ex-*Luftwaffe* op. 1983–wfu |
| 63-13254 | F-104G | 4375 | ex-*Luftwaffe* op. 1983–1.3.94 |
| 63-13255 | F-104G | 4376 | ex-*Luftwaffe* op. 1983–7.3.94 |
| 63-13257 | F-104G | 4377 | ex-*Luftwaffe* op. 1983–7.3.94 |
| 63-13260 | F-104G | 4378 | ex-*Luftwaffe* op. 1983–8.8.96 |
| 63-13262 | F-104G | 4379 | ex-*Luftwaffe* op. 1983–7.3.94 |
| 63-13264 | F-104G | 4380 | ex-*Luftwaffe* op. 1983–wfu |
| 63-13265 | F-104G | 4381 | ex-*Luftwaffe* op. 1983–7.3.94 |
| 63-13266 | F-104G | 4382 | ex-*Luftwaffe* op. 1983–1993 |
| 63-13269 | F-104G | 4383 | ex-*Luftwaffe* op. 1983–6.8.96 |
| 63-13272 | F-104G | 4384 | ex-*Luftwaffe* op. 1983–31.5.87 |
| 63-13273 | F-104G | 4385 | ex-*Luftwaffe* op. 1983–24.3.90 |
| 63-13690 | F-104G | 4386 | ex-*Luftwaffe* op. 1983–11.9.87 |
| 63-13691 | F-104G | 4387 | ex-*Luftwaffe* op. 1983–9.7.91 |
| 65-12745 | F-104G | 4388 | ex-*Luftwaffe* op. 1983–wfu |
| 65-12747 | F-104G | 4389 | ex-*Luftwaffe* op. 1983–7.3.94 |
| 65-12748 | F-104G | 4390 | ex-*Luftwaffe* op. 1983–wfu |
| 65-12748 | F-104G | 4391 | ex-*Luftwaffe* op. 1983–crashed 8.7.91 |
| 65-12751 | F-104G | 4392 | ex-*Luftwaffe* op. 1983–5.88 |
| 65-12753 | F-104G | 4393 | ex-*Luftwaffe* op. 1983–5.88 |
| 66-13526 | F-104G | 4394 | ex-*Luftwaffe* op. 1983–crashed 21.12.90 |
| 67-14885 | F-104G | 4395 | ex-*Luftwaffe* op. 1983–5.88 |
| 67-14887 | F-104G | 4396 | ex-*Luftwaffe* op. 1983–5.88 |
| 67-14889 | F-104G | 4397 | ex-*Luftwaffe* op. 1983–5.88 |
| 67-14890 | RF-104G | 4398 | ex-*Luftwaffe* op. 1983–28.8.95 |
| 67-14892 | RF-104G | 4399 | ex-*Luftwaffe* op. 1983–wfu |
| 67-22517 | RF-104G | 4400 | ex-*Luftwaffe* op. 1983–1989 |
| 62-12244 | RF-104G | 4401 | –28.3.89 |
| 62-122?? | F-104G | 4402 | –crashed 1.12.86? |
| 62-12340 | F-104G | 4411 | op. 24.2.87–wfu |
| 62-12342 | F-104G | 4412 | op. 6.8.87–16.3.94 |
| 62-12345 | F-104G | 4413 | op. 31.3.87–7.3.94 |
| 62-12347 | F-104G | 4414 | op. 2.4.87–1989 |
| 62-12348 | F-104G | 4415 | op. 1.4.87–7.3.94 |
| 62-12349 | F-104G | 4416 | op. 25.2.87–7.3.94 |
| 63-13645 | F-104G | 4417 | op. 6.4.87–7.3.94 |
| 63-13646 | F-104G | 4418 | op. 27.2.87–7.3.94 |
| 63-13647 | F-104G | 4419 | op. 30.3.87–wfu |
| 63-12699 | F-104G | 4420 | op. 18.2.87–28.8.95 |
| 63-12702 | F-104G | 4421 | op. 23.2.87–24.3.90 |
| 63-12703 | F-104G | 4422 | op. 2.4.87–7.3.94 |
| 63-12707 | F-104G | 4423 | op. 3.4.87–1996 |
| 64-17754 | F-104G | 4424 | op. 3.3.87–7.3.94 |
| 64-17755 | F-104G | 4425 | op. 24.2.87–7.3.94 |
| 46-8612 | F-104J | 4501 | –1990 |
| 36-8528 | F-104J | 4502 | –1989 |
| 36-8531 | F-104J | 4503 | –1990 |
| 36-8554 | F-104J | 4504 | –1990 |
| 46-8611 | F-104J | 4505 | crashed 9.12.89 |
| 36-8555 | F-104J | 4506 | –15.10.87 |
| 46-8569 | F-104J | 4507 | crashed 11.4.88 |
| 46-8570 | F-104J | 4508 | –1990/wfu |
| 26-8508 | F-104J | 4509 | –1990 |
| 26-8503 | F-104J | 4510 | –1990 |
| 46-8582 | F-104J | 4511 | crashed 5.12.90 |
| 26-8509 | F-104J | 4512 | –1990/wfu |
| 46-8614 | F-104J | 4513 | –1992 |
| 46-8616 | F-104J | 4514 | –1990 |
| 46-8618 | F-104J | 4515 | –1990 |
| 46-8619 | F-104J | 4516 | –1990 |
| 46-8627 | F-104J | 4517 | crashed 1.9.88 |
| 26-8502 | F-104J | 4518 | –1990/wfu |
| 46-8645 | F-104J | 4519 | –1990 |
| 46-8646 | F-104J | 4520 | –1990 |
| 36-8514 | F-104J | 4521 | –1990 |
| 46-8596 | F-104J | 4522 | –1990/wfu |
| 36-8547 | F-104J | 4547 | used for spare parts |
| 36-8525 | F-104J | | used for spare parts |
| 36-8526 | F-104J | | used for spare parts |
| 36-8541 | F-104J | | used for spare parts |
| 36-8556 | F-104J | | used for spare parts |
| 16-5003 | F-104DJ | 4591 | –1990 |
| 16-5004 | F-104DJ | 4592 | –1990 |
| 16-5006 | F-104DJ | 4593 | –1990 |
| 16-5016 | F-104DJ | 4594 | –1990 |
| 16-5017 | F-104DJ | 4595 | –1990 |
| 62-12241 | RF-104G | 5626 | op. 1963–crashed 30.3.69 |
| 62-12242 | RF-104G | 5628 | op. 1963–30.3.69 |
| 62-12243 | RF-104G | 5630 | op. 1963–1981 |
| 62-12244 | RF-104G | 5632 | op. 1963–crashed 28.3.89 |
| 62-12245 | RF-104G | 5634 | op. 1963–crashed 1981 |
| 62-12246 | RF-104G | 5636 | op. 1963–crashed 2.3.77 |
| 62-12248 | RF-104G | 5638 | op. 1963–crashed 14.2.86 |
| 62-12249 | RF-104G | 5640 | op. 1963–crashed 2.3.77 |
| 36-8565 | F-104G | | ex-*Luftwaffe* acquired 1980, used for spare parts |
| 64-15104 | TF-104G | | from Belgium 1990 (ex-FC-01) |
| 64-15105 | TF-104G | | from Belgium 1990 (ex-FC-02) |
| 64-15106 | TF-104G | | from Belgium 1990 (ex-FC-03) |
| | TF-104G | | from Belgium 1990 (ex-FC-04) |
| | TF-104G | | from Belgium 1990 (ex-FC-06) |
| | TF-104G | | from Belgium 1990 (ex-FC-07) |
| | TF-104G | | from Belgium 1990 (ex-FC-10) |
| | TF-104G | | from Belgium 1990 (ex-FC-11) |
| | TF-104G | | from Belgium 1990 (ex-FC-12) |
| | F-104G | | from Belgium 1990 (ex-FX-03) |
| | F-104G | | from Belgium 1990 (ex-FX-07) |
| | F-104G | | from Belgium 1990 (ex-FX-10) |
| | F-104G | | from Belgium 1990 (ex-FX-44) |
| | F-104G | | from Belgium 1990 (ex-FX-48) |
| | F-104G | | from Belgium 1990 (ex-FX-57) |
| | F-104G | | from Belgium 1990 (ex-FX-59) |
| | F-104G | | from Belgium 1990 (ex-FX-62) |
| | F-104G | | from Belgium 1990 (ex-FX-64) |
| | F-104G | | from Belgium 1990 (ex-FX-65) |
| | F-104G | | from Belgium 1990 (ex-FX-67) |
| | F-104G | | from Belgium 1990 (ex-FX-72) |
| | F-104G | | from Belgium 1990 (ex-FX-74) |
| | F-104G | | from Belgium 1990 (ex-FX-80) |

## CHAPTER NINE

# Shooting for the Stars

> *With its short wings and T-tail, the F-104 epitomized the features that caused inertial coupling. A marginal dog-fighter against the other century-series fighters, it was designed only to get to high altitude fast and pass by the enemy at high enough speed to avoid a dog-fight and a retaliatory missile. It was never intended to be a dogfighter; instead, it was a greyhound built to nip at the butt of the pit bulls as it passed by.*[23]
>
> Milton O. Thompson (1926–93)

**NASA F-104 Inventory**

| | | | |
|---|---|---|---|
| YF-104A-183-1007 | 55-2961 | N818NA | acquired 8.56 (op by NASA until 18.11.75) |
| F-104G-183-1022 | 56-0734 | | acquired, 7.10.57 |
| F-104G-183-1037 | 56-0749 | N824NA | acquired, 13.4.59. Lost 20.12.62 |
| F-104B-283-5015 | 57-1303 | N819NA | acquired, 16.12.59. Ret. 21.4.78 |
| F-104N 683C-4045 | (011) | N811NA | acquired, 8.8.63 |
| NF-104A (F-104A) | 56-756 | | del. 1.10.63. Ret. 20.12.71 |
| F-104N 683C-4053 | (012) | N812NA | acquired, 1.10.63. Ret. 3.2.94 |
| F-104N 683C-4058 | (013) | N813NA | acquired, 22.10.63. Lost 8.6.66 in mid-air collision with XB-70A Valkyrie) |
| NF-104A (F-104A) | 56-760 | | del. 26.10.63. Lost, 10.12.63 |
| NF-104A (F-104A) | 56-762 | | del. 1.11.63. w/o June 1971 |
| F-104G-183-1078 | 56-790 | N820NA | acquired, 27.12.66. Began operating in 1968. Ret. 1.6.77 |
| TF-104G-583D-5735 | | N824NA | (ex-27+33) arrived July 1975 |
| TF-104G-583F-5939 | | N825NA | (ex-28+9) arrived July 1975 |
| RF-104G-8213<br>(KG313/Fokker) | | N826NA | (ex 24+64) arrived July 1975<br>last NASA flight 3.2.94 |

It was Monday 17 August 1956, at the National Advisory Committee for Aeronautics (NACA) High-Speed Flight Station (HSFS) at Edwards AFB, California, that several employees watched as crew chief Dick Payne made sure that test pilot Joe Walker was properly strapped in, in the cockpit of the HSFS's first F0104 Starfighter. Walker taxied YF-104A 55-2961 off the ramp and onto the dry lakebed runway for take-off. Anxiety began to build. Soon the canopy closed and Walker moved the throttle forward for take-off. The F-104A responded to the thrust of its powerful J79 engine and off it went on a flight lasting approximately thirty minutes.

For almost twenty-two years, until 21 April 1978, NACA operated no less than fourteen F-104 Starfighters of various descriptions, six of them purpose-built NF-104As and six F-104Ns, on a variety of tasks in support of NACA/NASA space research projects. NACA, which became the National Air and Space Administration (NASA) on 1 October 1958, ultimately expanded to include the Lewis Aeronautical Laboratory, the Ames Aeronautical Laboratory, and the High Speed Flight Station, later the Flight Research Center, and then the Dryden Flight Research Center. Dryden primarily specialized in high-speed flight with aircraft such as the early X-series.

The three NF-104A Starfighters were F-104G models modified for use in training and candidate astronauts at the USAF Aerospace Research Pilots School (ARPS) at Edwards AFB, California. The three Lockheed-delivered F-104Ns and eight other Starfighters delivered to NASA and designated F-104N, were primarily used as supersonic chase planes. During the period 27 August 1956 to 21 April 1978 at least nineteen different pilots (sixteen from Dryden), two from Ames, and one from the USAF) flew the Starfighter during its NACA/NASA career. Included in this total are Apollo astronauts and X-15, lifting-body, XB-70A Valkyrie, and YF-12 pilots.

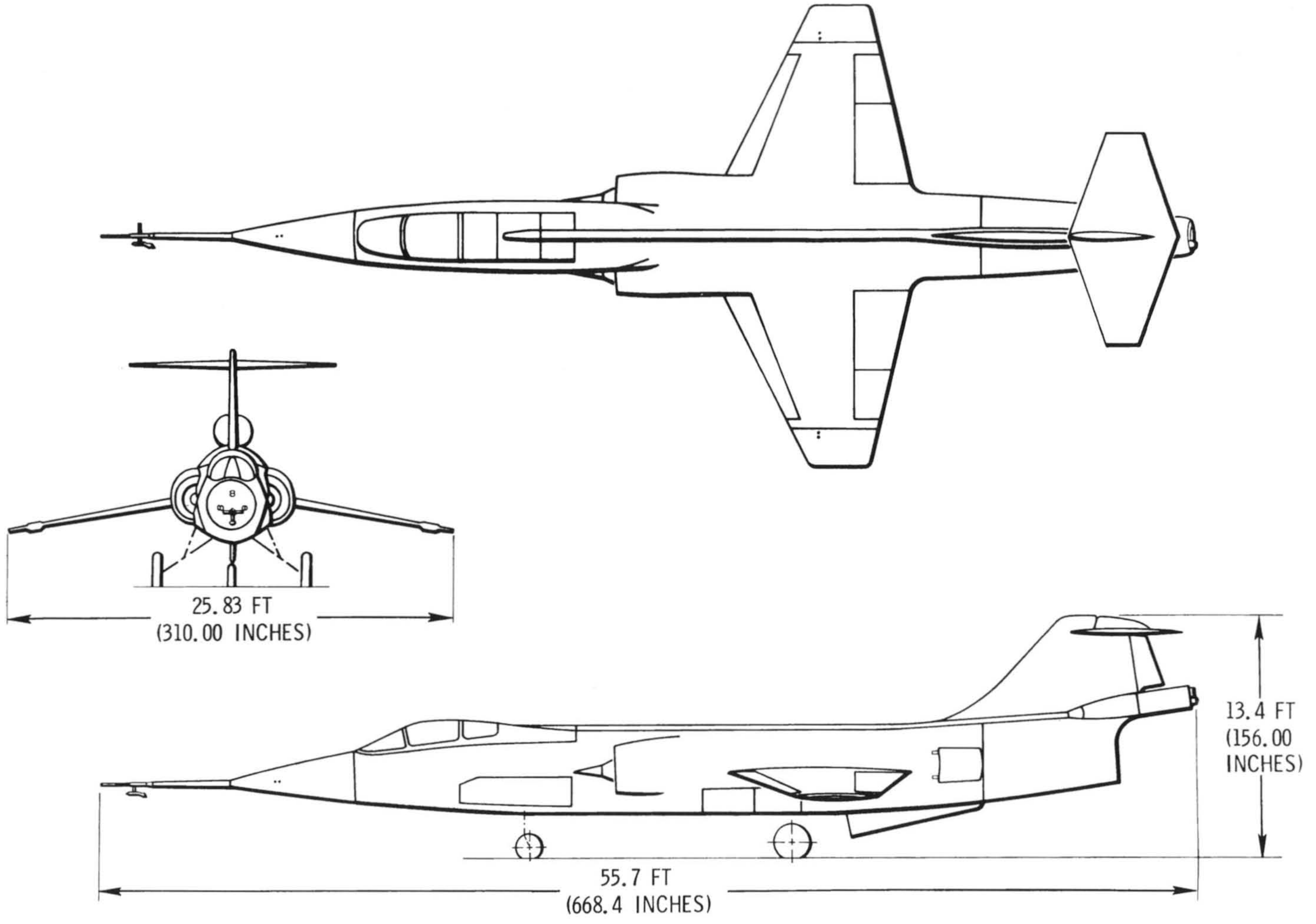
### *NF-104A Aerospace/Astronaut Proficiency Trainer*

Lockheed received a contract from the USAF Air Research and Development Command in 1962 to modify three F-104A Starfighters (56-756, 56-760, and 56-762) to Aerospace Trainer Aircraft configuration for use in training candidate astronauts at the USAF Aerospace Research Pilots School (ARPS) at Edwards AFB, California. ARPS was commanded by famed aviator, Colonel Charles E. 'Chuck' Yeager. The three NF-104s, which were modified in the Burbank experimental shops and trucked to the Flight Test Facility at USAF Plant 42 in Palmdale, were intended as testbeds for flights above the atmosphere to familiarize pilots with zero-G and the use of reaction control systems such as found on the Bell X-15. Simulated training using the NF-104As involved a much lower operating cost than using three X-15 aircraft.

In order to attain altitudes at which the reaction control system would function, each NF-104A received a Rocketdyne LR121/ AR-2-NA-1 liquid fuel auxiliary rocket engine of 6,000lb (2,720kg) thrust. This was mounted at the base of the fin above the jet pipe of the J79-GE-3B turbojet, which was retained. The rocket engine, which used JP-4 and hydrogen peroxide, which were hypergolic, was throttle controlled from 3,000 to 6,000lb thrust with approximately 1 minute 45 seconds' burn time. A hydraulically driven fuel boost pump replaced one of the electric pumps to provide JP-4 to the rocket engine

**Col (later Brig Cen) Charles E. 'Chuck' Yeager, who by 1962 had been named the commandant of the USAF Aerospace Research Pilots School (ARPS) at Edwards AFB, in the cockpit of one of the School's three NF-104Ns modified for use in training candidate astronauts. On 14 October 1947 Yeager became the first man to fly faster than the speed of sound, in the Bell X-1, and on 12 December 1953, he was the first man to fly twice the speed of sound, in the Bell X-1A. On 10 December 1963 Yeager was piloting NF-104A 56-0760 for another attempt on the altitude record when he experienced pitch-up and the NF-104A went spinning down to 25,000ft (7,600m). Yeager was forced to eject from 56-0760 at 8,000ft (2,440m). He survived, but suffered severe burns in this accident. Over a five-year period at Edwards, Yeager developed the curriculum and systems to train a whole new generation of test pilots, thirty-seven of whom were selected for the US Space programme, and twenty-six of whom earned astronaut wings. Chuck Yeager retired from active duty in 1975.** AFMC History Office

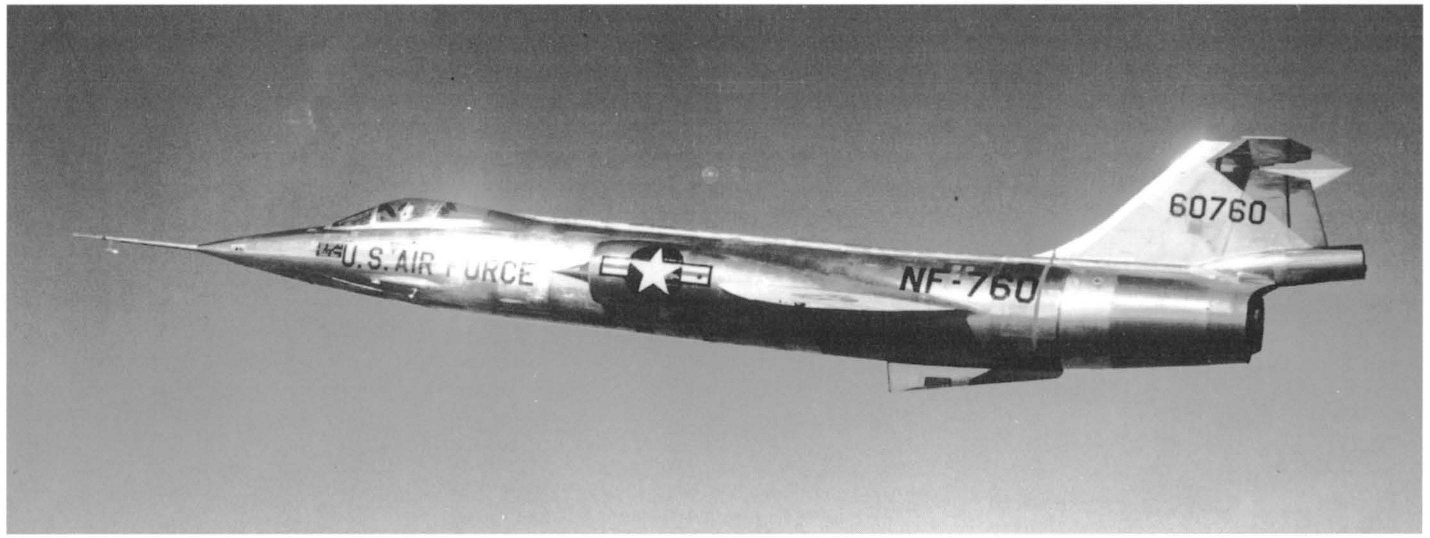
***(Below)* Lockheed NF-104A Aerospace Trainer.** Lockheed



following the loss of the AC generators in the ballistic portion of the flight profile.

The NF-10A had its original vertical fin replaced with the larger fin used on the TF-104G, wingspan was increased by 4ft to 25.94ft, a metal nose cone replaced the plastic one. To further save weight, all non-essential equipment, such as the Vulcan cannon, AN/ARC-66 UHF radio, AN/ASG-14T-1 fire control system, ILS, braking parachute, and auxiliary wingtip tanks, were removed. The two UHF radios which replaced the original were lighter, single-channel units with one mission frequency and one guard. The power output was about two watts and therefore had very limited range. It was not uncommon during the test programme for a pilot to run out of peroxide at altitude, lose control and come spinning back into the atmosphere unable to communicate with test directors because of these radios. New batteries for high-altitude power, an AN/APX-46 IFF system, special instrumentation, a Collins 718 radio, a pressure tank for cockpit pressurization, and a reaction control system, were installed. The wingtips were extended 2ft and the engine air inlet shock half-cones, modified.

**NF-104A-LO 56-0760, one of the three Starfighters modified in 1963 to be used in the USAF astronaut training programme conducted by the Aerospace Research Pilot School at Edwards AFB, California. They were fitted with a 6,000lb (2,722kg) thrust Rocketdyne AR-2 auxiliary rocket engine above the jetpipe, 2ft (61cm) wingtip extensions, the enlarged vertical surfaces of the F-104G, and hydrogen peroxide control thrusters at the nose, tail and wingtips.** Lockheed/AFMC History Office



**NF-104A-LO 56-0756 zoom-climbing over the Mojave desert, its Rocketdyne rocket motor at full 6,000lb (2,720kg) thrust. 56-0755 is now on display at the USAF Test Pilots School.** Lockheed

To enable the astronauts to get the feel of the hydrogen peroxide controls with which they would steer their space craft, each NF-104A was provided with control thrusters at the nose, tail, and wingtips. Reaction control thrusters were added in the test nose boom with pitch and yaw vanes, and on the wingtips for roll control. A separate 'stick' controller was installed on the instrument panel for the reaction control system. A three-axis reaction control damper system was also added, sharing the thrusters with those of the primary control system. These systems also used hydrogen peroxide for fuel. Internal tanks were added for the peroxide. A nitrogen pressurized cockpit was also installed. The empty weight of the NF-104A was only 13,400lb (6,080kg) and gross take-off weight just 21,800lb (9,890kg).

The first NF-104A (56-0756) was delivered to Edwards AFB on 1 October 1963, the second (56-0760) on 26 October, and the third (56-0762) on 1 November.

James P. Fitzgerald recalls:

> One episode just prior to the first planned rocket engine firing on 56-762, the first modified and primary flight test airplane, nearly made a widow of our shop foreman's wife. Frank Harvey had just completed a visual inspection of the rocket motor nozzle and was descending the access stand when test pilot Jack Woodman, per the test card, depressed the rocket timer 'Clock Reset' button in the cockpit. The rocket motor immediately ignited. Once Jack got it shut down, we engineers unrolled the prints right under the airplane and discovered to our horror that a sneak circuit had been designed into the clock reset wiring which applied power directly to the turbopump valve when the clock was reset. A diode solved this one and we pressed on.

### Altitude Record Attempts

On 15 November 1963 56-756, in the hands of Maj Robert W. Smith, climbed to 22.5 miles (118,860ft), (36,229m) an unofficial world altitude record from a ground take-off at Edwards AFB. (A height record of 113,890ft (34,714m) had been set by the Soviet Union in 1961). On 6 December 1963 56-756 reached 120,800ft (36,820m).

Six days later, on the morning of 12 December, Chuck Yeager took off in NF-104A 56-0760 and made it to 108,000ft 932,918m). It went 'beautifully'[24] and Yeager was scheduled for another attempt on the altitude record in the afternoon. After lunch he took off and climbed to 35,000ft (10,670m), about 100 miles from Edwards at the bottom end of the San Joaquin Valley near Fraser Peak, and headed for Rogers Dry Lake at 37,000ft (11,280m) in afterburner. Yeager was flying at more than Mach 2 when he fired the 6,000lb (2,720kg) thrust rocket in the tail. By this time he was climbing at a steep 70 degree angle. Passing 60,000ft (18,290m) as expected, the afterburner flamed out, oxygen-starved in the thin atmosphere. Later, when he reached 40,000ft (12,190m), Yeager planned to enter a shallow dive to permit the compressor blades to windmill in the rush of air, working up the required revolutions enabling reignition in the lower air. He shut down the engine and let the rocket motor carry him over the top at 104,000ft (31,700m).

Now, as the angle of attack reached 28 degrees, the NF-104's nose pitched up (something which had happened in the morning flight). Yeager used the small peroxide thrusters on the nose to try to push it down but the nose refused to lower (the stabilizer had frozen into the climb position) and the NF-104 fell off flat and went into a spin. Bud Anderson, flying the T-33 chase plane, saw Yeager 'coming down like an autumn leaf off a tree'. The NF-104 was falling 'so flat and so straight' that Anderson could circle him and 'kind of corkscrew down with him'. They went through about 14,000ft (4,200m) and Anderson said, 'Hey Chuck, that's enough. Get out.'

Yeager's engine had wound down to the point where it stopped and locked at about 40,000ft (12,000m). (The data recorder later indicated that the Starfighter made fourteen flat spins from 104,000ft (31,700m) until impact on the desert floor. Yeager stayed with the aircraft through thirteen of these spins before he ejected safely at 8,000ft (2,438m) – he hated losing an expensive aircraft but there was nothing more that he could do).

The seat functioned normally and out went Yeager upwards at 90mph. However, following seat–man separation, the seat, which still had a residual fire in the back from the rocket charge, became entangled in his parachute risers, or shroud lines, and the risers began smouldering. Fortunately, the lines had not burnt through and the chute opened, much to Yeager's relief, but the popping motion dislodged the seat, and the tube end of the rocket motor, which was glowing red hot, smashed into Yeager's pressure suit faceplate, hitting his left eye. The blow broke the faceplate and deposited unburned rocket propellant inside the helmet. Burning material on the seat ignited the rubber seal around Yeager's helmet and in the 100 per cent pure oxygen environment inside the pressure suit it 'erupted like a blow torch'. Yeager's head was engulfed in flames and smoke. He could not breathe, nor could he see out of his left eye. Yeager thrust his gloved hand into the open faceplate and tried to scoop in air to breathe but the rubber-lined glove caught fire. Instinctively, he pushed up the visor on what remained of his helmet. An action which automatically shut off the oxygen feeding in from the emergency bottle. Close to the ground now, Yeager hit the desert floor hard. Yeager had survived but he was hospitalized for a month while surgeons treated his severely burned face and hands. He also lost the tips of two of his fingers using a knife to cut off his burning glove).[25]

### Further Testing

James Fitzgerald recalls:

> The typical mission profile for the NF-104A involved a level acceleration at 35,000ft to Mach 1.9, ignition of the rocket motor at nearly full rated thrust, start a shallow climb while continuing to accelerate to Mach 2.1, a rapid 3.5G pullup into a steep climb at 50 to 70 degrees pitch altitude and 11 degrees alpha. The J79 afterburner would normally blow out at about 70,000ft, followed by the main engine at 80,000ft. The rocket motor continued to run until fuel starvation (as mentioned, about two minutes total). At this point the airplane was well over 100,000ft and reaction controls were exercised to effect a push-over and re-entry manoeuvre. J79 restart was initiated at 40 to 35,000ft and following restart, return to base (RTB). It was standard practice upon return from a flight above the stratosphere to conduct a precautionary simulated flame-out approach to landing. Many times pilots landed with 400–500lb of fuel remaining, which in the F-104 represents the proverbial 'fumes'. The test programme consisted of 42 flights between 9 July and 29 October, the average duration of which was 34 minutes due to the mission profile.
>
> Some of the challenges involved in this programme were several redesigns of the reaction control system stick to provide the proper 'feel', development of a technique to bleed the hydrogen peroxide fuel lines prior to rocket motor ignition to preclude late lightoffs, and development of the accel/pullup technique to optimize zoom altitude. On one test flight, the reaction control system was inoperative, and because of the ineffectiveness of the normal control surfaces, an unplanned pitchup and spin resulted during the zoom recovery. This incident emphasized the need for the reaction control system for recovery. Since JP-4 and hydrogen peroxide are hypergolic, any fuel leaks were, of course, intolerable.

In June 1971 the third NF-104A (56-0762), suffered an explosion at Mach 1.15 while at 35,000ft (10,670m). The explosion was caused by a failed O-ring which allowed leaking hydrogen peroxide into the Starfighter's rear fuselage. Capt Howard C. Thompson, the pilot, was able to safely land the aircraft but it had lost half its rudder and rocket motor. In any event the programme was nearing its end, so 56-0762 took no further part in training. Combined, the first and third NF-104A flew a total of 126 flights, the last being made on 20 December 1971. 56-0760 is now on display at the USAF Test Pilots School.

### *F-104s for NASA-related Programmes, 1956–75*

Meanwhile, between August 1956 and October 1963, NACA/NASA acquired eight F/TF-104 Starfighters second-hand from the USAF. These (plus three F-104Ns which arrived in 1963, and three ex-*Luftwaffe* machines which followed in the summer of 1975) were used for a variety of roles, including basic research of the transonic and high supersonic regions, and as aerodynamic testbed facilities to obtain data for projects and experiments quickly and at low cost, as well as an airborne simulator for the X-15 and lifting body programmes. They were also used in a support role as safety/photo chase or to maintain pilot efficiency in high performance aircraft. On a few, rare occasions, they were used to launch or drop test vehicles.

NACA's first use of the Starfighter was to investigate inertial or roll coupling, a new phenomenon which primarily was a result of the new aircraft configurations which appeared in the late 1950s.[26]

> Everything, including the fuel, was packed into a small, high fineness ratio fuselage, with short wings and tails to minimize frontal area and drag. It was great from the aerodynamic performance standpoint but it had some other insidious effects. The mass of the aircraft was concentrated close to the roll centreline, while the damping from the wing was minimized for the

**NF-104A 56-0760 of the Air Force Flight Test Center, Edwards AFB, California, taxiing with another NF-104A on the runway in May 1965.** Warren Bodie via Robert F. Dorr

> same reason. When the aircraft made a turn, its angle of attack (the angle between the airflow and the wing) would change. Under certain specific conditions of speed, altitude and roll rate, the plane's stability would decrease and it would suddenly go out of control.

The X-1A's loss of control at Mach 2.4 in December 1953 (when Chuck Yeager recovered from a subsonic inverted spin and landed successfully), and the crash of the X-2 in November 1956 (in which Capt Milburn Apt was killed), had been caused by inertial coupling. Joe Walker had encountered inertial coupling during high roll rates on an October 1954 flight of the X-3 aircraft. That same month, several F-100As were lost when they broke up in flight. One of the pilots who was killed was George Welsh, North American chief test pilot. It appeared that the accident had been caused by inertial coupling.

NACA successfully identified the F-100A's catastrophic inertial coupling characteristic by flying 45 F-100 flights to define the limits. Ultimately, an enlarged vertical tail was installed to enhance directional stability and roll damping. This success led the Air Force to offer one example of each new century series fighter to NACA to conduct a similar independent evaluation exercise. With its short wings and T-tail, and all the weight confined within a short distance of the aircraft centreline, the F-104 Starfighter epitomized the features that caused inertial coupling.

In August 1956 NACA received its first Starfighter (the seventh service test YF-104A) when it took delivery of 55-2961 (which was originally numbered 018, later N818NA). An agreement was reached whereby the NACA High Speed Flight Station at Edwards conducted a major test programme using N818NA with Joe Walker as project pilot, to investigate inertia coupling phenomena believed to be responsible for many Starfighter losses. This investigation produced a mass of data. A subsequent test programme investigated the engine flame-out problem that plagued the early F-104 Starfighters. The cause was determined to be asymmetrical airflow into the engine compartment from the inlet ducts. As a result, a vertical duct-splitter was installed at the engine face to balance the inlet airflow and thus alleviate the problem.

The US Air Force really wanted their F-104 back after the evaluation but NACA was reluctant and finally the US Air Force agreed to let NACA keep 55-2961. (This Starfighter was operated by NASA until November 1975.) Later, N818NA was fitted out with a jet reaction control system to augment an earlier programme that used the X-1B rocket aircraft to give pilots experience in flying these systems. During this programme the Starfighter successfully performed zoom climbs to the 90,000ft (27,500m) region. This work with reaction controls provided the first research experience for pilots controlling an aircraft at dynamic pressures below 20lb per square foot where conventional controls lose their effectiveness.

The second Starfighter to be delivered was 56-0734, on 7 October 1957 and it received the NASA number N820NA. This Starfighter was acquired initially to determine whether natural laminar flow could be achieved at supersonic speeds using an optimum airfoil surface. Neil Armstrong made the first flights in this investigation which were continued by Milton O. Thompson. The optimum airfoil surface was achieved by applying a fibreglass coating on the right wing of N820NA, which was subsequently shaped and smoothed to achieve an almost perfect airfoil surface. Thermocouples were installed in the fibreglass layer to measure the surface temperature and in this manner determine whether the airflow over the surface was laminar or turbulent. Turbulent flow imparted more heat into the fibreglass than smooth laminar flow. Surprisingly, the investigation worked as conceived – laminar flow was achieved on the fibreglass-coated wing over the forward 25 to 30 per cent of the wing. The standard left wing was also instrumented and revealed a much lower amount of laminar flow.[27]

56-0734 was then used in measuring boundary-layer noise on a smooth polished nose cone that was substituted for the production nose cone, an experiment that provided data to compare with wind tunnel data for calibration purposes.

NASA needed to test the Mercury capsule drogue chute which was to be deployed at supersonic speed to stabilize and decelerate the capsule prior to deployment of the main recovery chute. There was no convenient way to test and demonstrate the operation of this chute and so Dryden proposed using a modified F-104A. NASA therefore requested the loan from the US Air Force of an F-104A that had been modified with a weapons rack under the belly of the aircraft. On 13 April 1959, 56-0749 (1037) became the third Starfighter to be acquired by NASA. (It subsequently received the NASA number, N824NA.) The weapons rack could be extended below the aircraft, allowing large rockets or missiles to be fired without endangering the aircraft. It was the only Starfighter to be modified in this manner. NASA used N824NA to carry a bomb-shaped simulated Mercury capsule to the planned speed and altitude for operational deployment. The dummy capsule would contain instrumentation to measure the deployment loads and a drogue chute with its associated deployment hardware. The dummy capsule weighed as much as the Mercury capsule, roughly 1,800lb (815kg). NASA calculated that they could launch the dummy capsule at 70,000ft (21,330m) at Mach 1.2 or greater. The dummy capsule was intended to impact the Edwards bombing range and then be reusable for successive launches. Joe Walker flew this series of flights.

56-0749 was next configured for the Alsor programme to launch a large balloon, 10ft (3m) in diameter, to 1,000,000ft altitude using a rocket mounted on the extended launch rack. The purpose was to measure the density of the atmosphere at a location on the X-15 flight track that would allow researchers to calculate the true altitude airspeed, and dynamic pressure of the X-15 after a mission. Programme pilot Milt Thompson described this endeavour as 'not very successful, but interesting'.

The programme began with a near-vertical launch of the rocket carrying the balloon. At peak altitude, estimated to be in excess of 800,000ft (244,000m), the nose cone would separate from the rocket and the balloon would be deployed. It would be inflated by a drop of water inside the balloon that theoretically would vaporize at the near vacuum pressure at these altitudes. The balloon would be tracked by radar and its descent measured. From this, HSFS personnel could compute air density. Altitudes of 600,000ft (182,880m) were achieved on three occasions. HSFS personnel, however, were never able to track the balloons on any of the trial launches after the nose cone separated from the rocket.

On 20 December 1962 after completing a routine weather check prior to an X-15 mission, Milt Thompson was practising low lift-drag approaches in 56-0749 when on one of the approaches one of his flaps extended, leaving Thompson with an asymmetric flap configuration. Initially, he was able to control the roll caused by this configuration but subsequently the aircraft became uncontrollable and he was forced

to eject at about 20,000ft (6,100m). Thompson landed near a road and hitch-hiked back to Edwards. (Thompson flew 23 different types of aircraft as a research pilot from 1956 to 1965, after which he remained at NASA in several management positions).

On 16 December 1959 57-1303, a two-seat F-104B, was added to the NASA inventory and was numbered N819NA. First assigned to Ames Research Center, this Starfighter was acquired by Dryden where NASA headquarters had decided to concentrate all of its high-performance aircraft research programmes. The F-104B was used to conduct some zero-g experiments, initially involving a small tank designed to supply fuel continuously under zero-g conditions. It was also used for indirect viewing experiments using a periscope in the rear cockpit. At hypersonic speeds the windshield of an aircraft can exceed 2,000°F and needs heavy and specialized glass to withstand the enormous temperatures. If the windshield could be done away with and replaced with, say, a periscope for pilot viewing, then a large saving in weight could be achieved. It was found that the field of view was an outstanding 180 degrees laterally and about 60 degrees vertically. Apart from exaggerating the stereoscopic effect and causing some errors in depth perception, and the need for the pilot to keep his head and eyes pressed against the eyepieces during elevated g manoeuvres, the system was quite successful and test pilots used it to make step simulated X-15 unpowered landings.

The F-104B also enabled an instrumented individual to be carried in the rear cockpit with the safety pilot flying the aircraft from the front cockpit. As a result, numerous biomedical experiments were carried out in the F-104B, many of which were applicable to the space programme. One such programme was the development of instrumentation and mini-recorder to monitor the pilot's physiological parameters (heart and respiration rates, oxygen consumption and pulse wave velocity). Recording the pulse wave velocity provided definition of the time delay in the pulse wave travelling from the heart to an extremity, in this case the small fingertip. These data allowed researchers to measure and predict the pilot's workload. A spin-off from the biomedical experiments was a 'spray-on-electrode' used to obtain flight electrocardiograms that was developed by the staff along with an atomizer spray gun. Another major spin-off was the real-time electro-cardiogram currently used in ambulances by paramedics all over the world.

Other programmes included the development of an in-flight mass spectrometer to analyse breathing, and liquid-cooled clothing. The initial Ground Command Guidance (GCG) system, the forerunner of the Remotely Augmented Vehicle (RAV), was also tested on this Starfighter. The Focused Boom Experiment was a unique programme used to demonstrate the capability of the GCG. This experiment, affectionately known as 'Big Boom', required that a ground track profile (loaded in a ground-based computer) and certain pertinent parameters, data-linked to instruments in the cockpit, be flown so that the energy from the sonic boom generated would be focused on a specific area on the ground. The F-104 aircraft was deployed to Michael Army airfield at Dugway, Utah, for this programme and used the Ely, Nevada, radar-tracking site to support these flights.

The fifth Starfighter to be acquired, on 27 December 1966 was F-104G 56-0790, which was numbered N820NA, although it needed modification and was not put into operation until April 1968. In addition to its support role at NASA, 56-0790 also made a major contribution to research as a test-bed aircraft, being used in the acquisition of the baseline data used in the development of the Centre's aircraft agility techniques programme. In response to an informal request from the Federal Aviation Agency (FAA), the initial flights to investigate the wake vortices of jumbo jet aircraft were flown with this F-104 probing the wake of a C-5 Galaxy. The data obtained on these flights were used as the criteria to establish an inertia minimum separation distance for aircraft trailing jumbo jet aircraft. (A major programme to investigate various wake vortices characteristics was later completed by NASA and the FAA.)

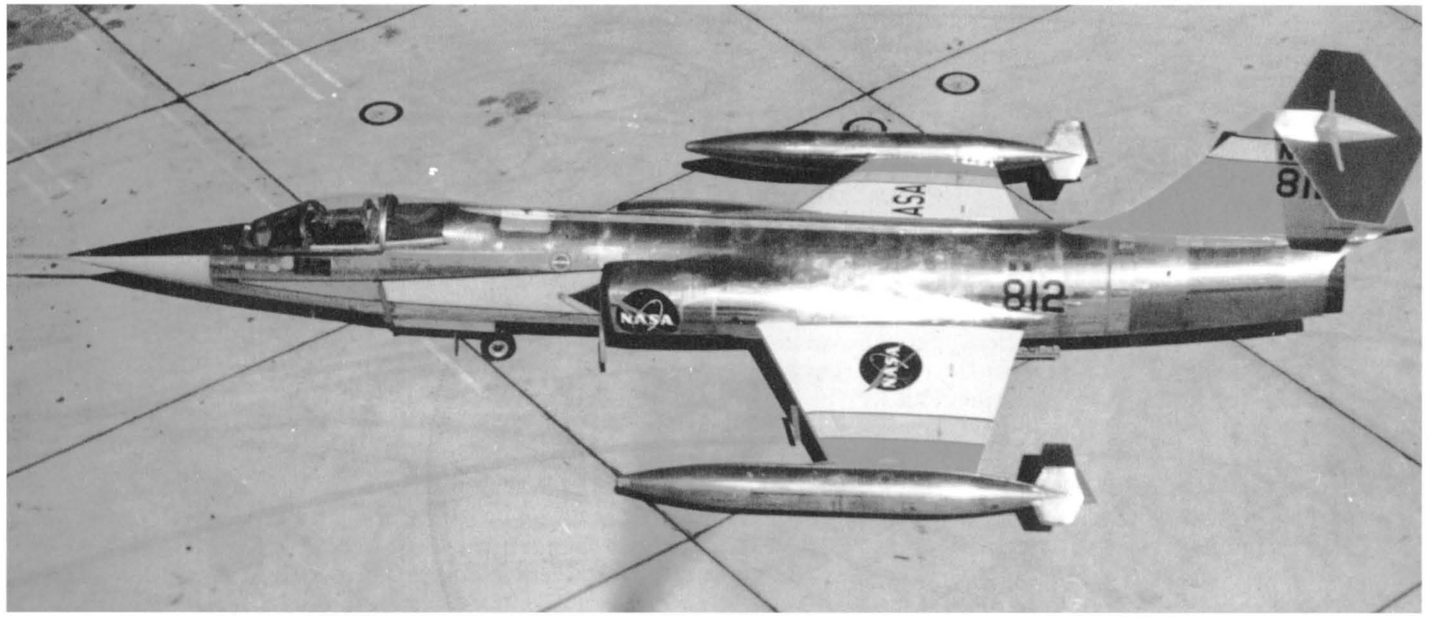
## *F-104N*

Three Starfighters built as F-104Gs by Lockheed (683C-4045, 683C-4053, and 683C-4058) were delivered to NASA between August and October 1963 as F-104N supersonic chase planes. Initially, they were numbered 011 (acquired 8 August); 012 (acquired 1 October), and 013 acquired 22 October). 011 and 012 were renumbered N811NA and N812NA. 4058 retained the F-104G (MAP) avionics suite, while NASA decided to reduce the avionics capabilities of 4045 and 4053. The LN-3 Internal Navigator was removed and replaced by VOR/ILS receivers, and in effect NASA went backward in the avionics configuration. These three F-104Ns were used for experimental projects and for chase duties.

On 8 June 1966 Joe Walker flew F-104N 013 as part of a formation of aircraft that were powered by General Electric engines. The other aircraft – all provided by the Flight Test Center – were the No.2 North American XB-70A Valkyrie, piloted by Alvin S. White, the North American test pilot, and Major Carl C. Cross, a new USAF Flight Test Center project pilot; a US Navy F-4B Phantom, flown by a crew from Point Magu; a YF-5A, flown by John Fritz, a General Electric test pilot; and a T-38 Talon, flown by Peter Hoag and Joe Cotton. Clay Lacey, the famous aerial photographer, was hired by General Electric to photograph the formation from a Lear Jet.

The formation, consisting of the F-104N and YF-5A off the XB-70A's right wing and the T-38 and the F-5B off the left, flew a racetrack pattern around Edwards. Suddenly, Walker's F-104N pitched up and rolled to the left, toward the Valkyrie. 013 continued up and over the XB-70A's wing, colliding with the twin vertical tails, severely damaging the right tail and tearing off the left tail. The Starfighter broke in two and exploded in a ball of flame following the collision and burned as it fell towards the Mojave desert. Walker had no time to eject and was found dead in the cockpit still strapped to his seat. Aboard the Valkyrie, neither White nor Cross had felt the collision. White even thought that two other aircraft in the formation had collided. The XB-70A flew on for 16 seconds then suddenly rolled off to the right and appeared to enter a spin, finally impacting in the desert 12 miles north of Barstow. White managed to eject after some initial difficulty with his escape capsule. Cross died in the aircraft cockpit.

Many theories as to the cause of the accident were aired. One theory blamed strong local vortices near the wingtip that sucked the F-104 into the Valkyrie. The accident investigation board finally concluded that Joe Walker had misjudged the position of his horizontal tail relative to the downward deflected tip of the XB-70A wing (which complicated judging relative separation or clearances between the two aircraft). As he



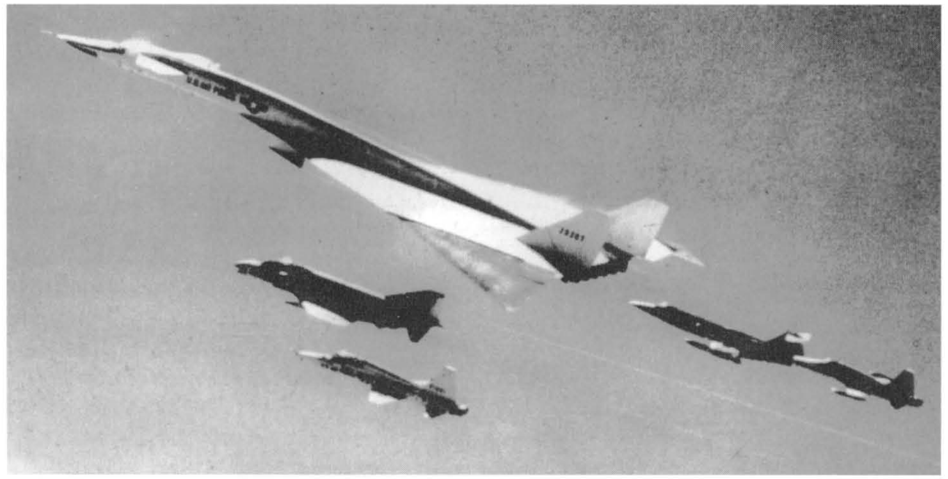
**F-104/N 683C-45053 (012) N812NA the second of three F-104N supersonic chase planes acquired by NASA, on 1 October 1963, in its original NASA colour scheme at Edwards AFB, around 1966. N812NA was used until 3 February 1994.** AFMC

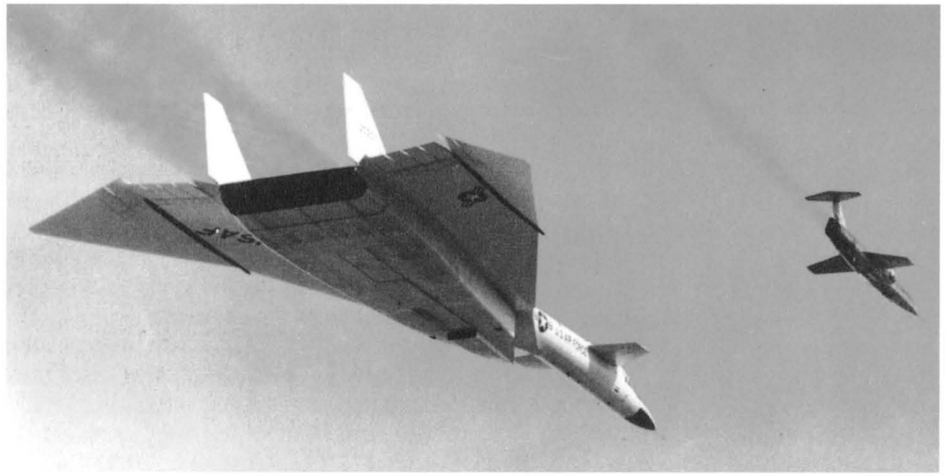
flew in formation the Starfighter's tail touched the downward deflected tip of the XB-70A wing, which then caused this aircraft to pitch up and roll over the wing and hit the two vertical tails.

### *The Germans Are Coming*

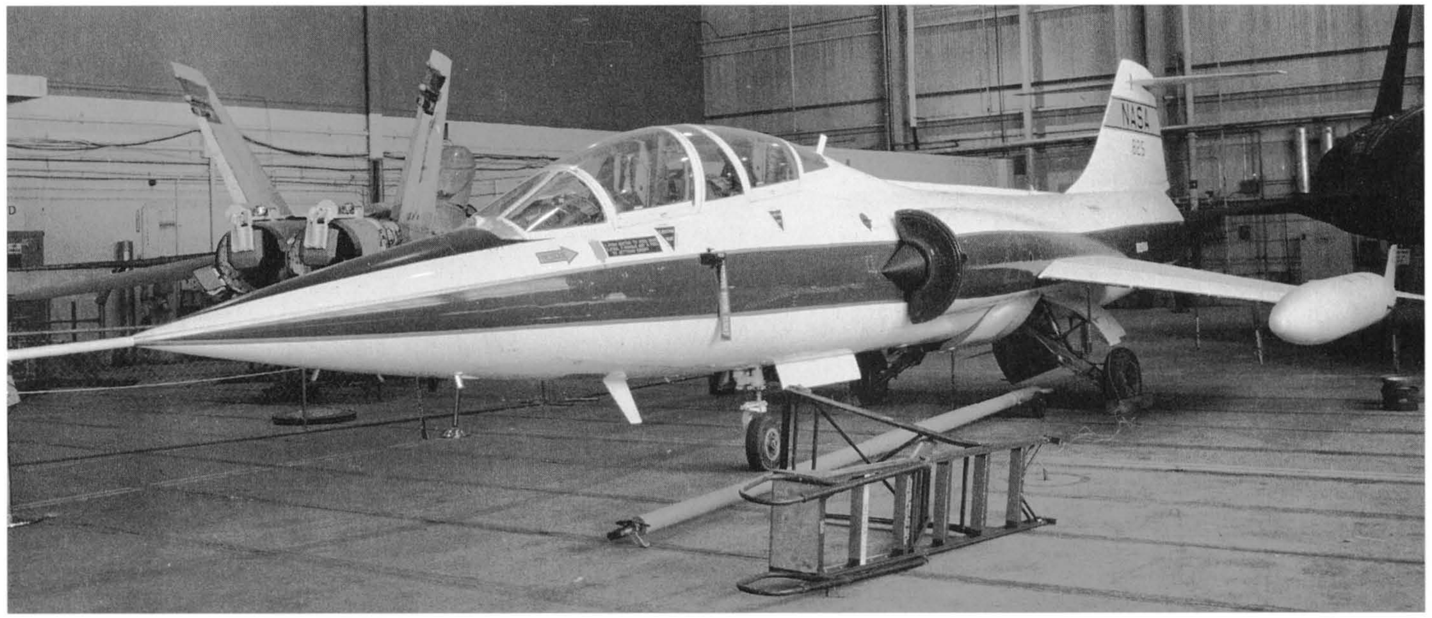
During the period 10 April 1969 to 19 December 1969, Dryden flew a total of 134 Starfighter missions, including ninety flights to gather data for six different research projects. These flights were accomplished in 176 regular scheduled work days, 138 of which were unavailable for flight because of downtime to experimental equipment. During this eight-month period there were no aircraft or instrumentation problems.

In July 1975 the NASA Starfighter fleet took on an international flavour with the arrival of three German Air Force F-104 – two TF-104Gs and a Fokker-built RF-104G. A 'NASA Blue Flyby' at 1015 hours on Wednesday 2 July was the climax to a journey that began six days earlier at Jever Air Base in West Germany for four of the Flight Research Center's elite test pilots Tom McMurtry (flying N824NA/ex-27+33), Bill Dana and Einar Enevoldson (N825NA/ex-28+09) and Gary Krier (N826NA/ex-24+64). An appropriate ceremony was held on the NASA ramp, where the pilots were duly honoured for their achievement. The addition of these three newer versions of Starfighter meant that replacement parts would be more readily available for them than they were for the earlier models, and they would therefore be easier to maintain and support.

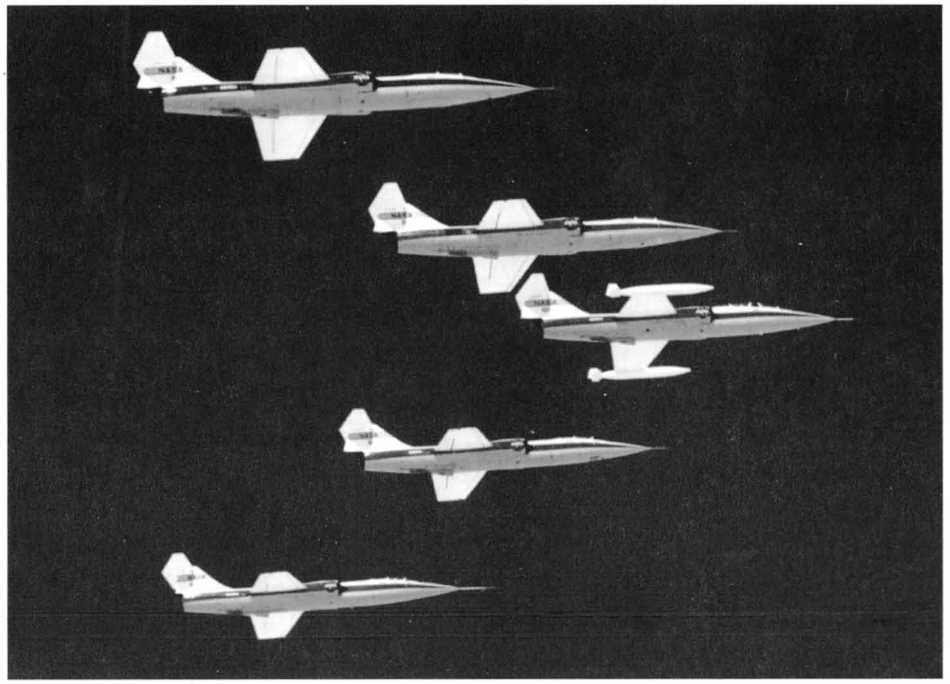




**The General-Electric-sponsored publicity flight on 8 June 1966, just before the collision of the No.2 North American XB-70A Valkyrie with F-104G/N (013) N813NA directly behind. The pilot of 013, Dr Joseph A. Walker, and Maj Carl S. Cross USAF, co-pilot of the Valkyrie, were both killed. Alvin S. White, pilot, survived.** via Philip Jarrett/AFMC History Office



**TF-104G-583F-5939 N825NA (ex-**Luftwaffe **28+9), which arrived at NASA in July 1975.** Mick Jennings



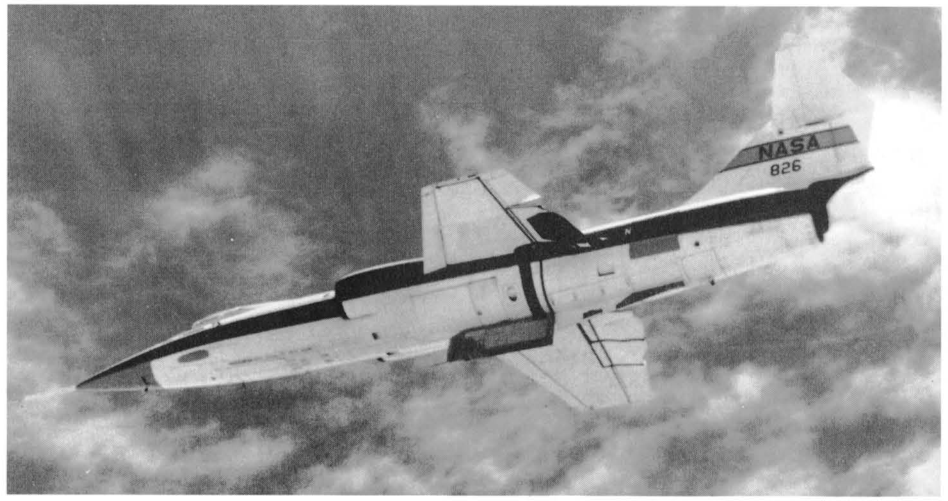
***(Right)*** **NASA's last five remaining F-104 Starfighters, Friday, 11 April 1975. N819NA is flown by Fitz Fulton and Ray Young, flight test engineer. Formation leader, in N811NA was Bill Dana. Tom McMurtry piloted N812NA and Einar Enevoldson was in N819BNA. Gary Krier piloted N820NA. A T-38 photo chase plane piloted by Chief Test pilot Don Mallick with photographer Bob Rhine in the back, took the picture.** NASA

### *NASA Starfighters' Nadir*

On 18 November 1975 F-104A N818NA (55-2961), NASA's first Starfighter, with Chief Test pilot Don Mallick at the controls, was flown off to a place of honour at the National Air and Space Museum in Washington DC. It was a fitting tribute to an aircraft which during its illustrious career had been flown at speeds greater than Mach 2 and at altitudes above 85,000ft (26,000m). From the initial stability and control handling qualities evaluation and propulsion programmes (research to obtain data on the basic F-104 aircraft) to the last testbed experiment flown, this Starfighter provided invaluable aerodynamic data. In addition to the roll-coupling evaluation, interaction of nonsteady twin-inlet flow study, jet-reaction control programme and many others, N818NA flew the Panel Flutter Flight-Test programme to obtain in-flight data about the aerodynamic phenomena known as Panel Flutter. This programme also compared these data accurately with the results of wind-tunnel studies.

Another programme on this Starfighter obtained flight-test verification of wind-tunnel data on two configurations for reducing base drag (retarding forces). This 'Two-Dimensional' Base Drag reduction experiment also demonstrated devices for breaking down major vortices, thereby also reducing base drag. In a separate programme, N818NA was used to study and develop the low-lift/low-drag landing technique used by pilots during the X-15 rocket research aircraft and Lifting Body programmes, thereby contributing

*(Above)* **F-104G-183-1078 56-0790 N820NA, which was acquired by NASA on 27 December 1966. It was operated from 1968, first as a research test aircraft, and then as a support aircraft, logging a total of 1,022 flights, until retirement on 1 June 1977 when it was put on permanent display at Edwards AFB.** Mick Jennings



**RF-104G-8213 N826NA (ex-24+64) which was acquired in July 1975, was used as a research platform and also as a support aircraft for other research missions. When it was pictured in August 1980, thermal protection tiles for the Space Shuttles, mounted on the trailing edge of the F-104's left wing flap, were flight tested. These test tiles were representative of the tiles located on the trailing edge of the Orbiter's elevon control surface. NASA Dryden had already successfully completed flight testing of two other tile locations on an F-15 aircraft at speeds of Mach 1.4 (approximately 825mph (1,327km/h) at altitudes of 30,000ft (9,140m). Dynamic pressures of 1,140lb per square foot were attained to simulate the aerodynamic loads that would be reached by the Space Shuttle during its launch. The completed tests evaluated tiles that were located on the forward section of the Orbiter's glove leading edge and the underside of the wing's leading edge. Three more sections representative of the tiles on the vertical tail, the window post, and elevon control surface hinge covering were prepared for future flight tests.** NASA/AFMC History Office

tremendously to those two significant milestones. N818NA even served as an airborne simulator of landing patterns and approaches for the pilots who flew the X-15 and the wingless vehicles.

N818NA had devoted 59 per cent or 1,444 flights to obtaining data for research programmes. Nineteen different NACA/NASA pilots had flown this Starfighter during these missions. Three of the pilots, including Neil Armstrong, the first astronaut to walk on the moon, in 1969, were Apollo astronauts. Seven, including Joe Walker, who holds the unofficial altitude record of 354,200ft (107,960m) flew the X-15, and four flew the X-15 above the 50-mile (80km) altitude necessary to qualify as winged astronauts. Six flew one or more Lifting Body Vehicles tested at Dryden.

The retirement of F-104 N820NA on 1 June 1977 followed, after a career spanning nine years and 1,022 total flights. It had first been a research test aircraft and then enjoyed a second career as a support aircraft along with N811NA and N812NA. Dryden's F-104 N820NA logged a total of 1,022 flights, including 308 flights to obtain data for research programmes. In its role as a research test aircraft, it gathered data for a number of experiments that made significant contributions to the aircraft community. From the initial Profile optimization experiment (Phase 1) to the last instrumentation validation test, N820NA provided invaluable aerodynamic data.

The Profile Optimization experiment consisted of two phases in which state-of-the-art, trapdown inertial systems would be flown aboard the aircraft. The computer was programmed to optimize a predetermined parameter and performed this operation in real time by providing the pilot with steering commands in the display system of the aircraft. Data gathered during this experiment advanced strapdown inertial system technology as applied to terrestrial vehicles. This experiment also provided operational experience with an airborne digital computer for its use as a research tool in the investigation of control, guidance and airborne simulation technology. In addition, this experiment yielded an especially interesting data point. For one test, a top speed of Mach 2.0 at 50,000ft (15,240m) was the objective. However, N820NA flew three different 'optimum' profiles to obtain that end point. One profile was computer generated. A second was the more or less standard profile used by the military, and the third was one Project pilot Einar Enevoldson developed to reach 50,000ft (15,240m) altitude.

A second major experiment flown on N820NA obtained data for the development of the Center's aircraft agility techniques. These data permitted an evaluation of the effects of certain parameters (buffet, wing rock, high g forces and so forth, on the piloting precision of a closed-loop tracking task. These data were obtained by using a 'target' aircraft to fly a predetermined profile while being tracked by the test F-104 N820NA. Other experiments included validation of instrumentation and data sensors that would be flown on other test aircraft such as the YF-12 and the F-8 Supercritical Wing aircraft. During its initial career as both a research and support aircraft, N820NA devoted 57 per cent of 308 flights to obtaining data for research programmes.

N820NA provided support for such research programmes as the YF-12, the basic F-15 tests, the F-111 TACT and the lifting bodies. Like other NASA F-104s, it served as an airborne simulator of landing patterns and approaches for the wingless-body vehicles. Ten different pilots (nine from NASA and one from the Air Force) flew this Starfighter. These included a Center director and Apollo astronaut, Dave Scott; an X-15 pilot, Bill Danda, who made the last X-15 flight over 300,000ft (91,440m) as well as the last flight in the X-15 programme; three lifting-body pilots, John Manke, Bruce Peterson and Bill Dane; and two YF-12 pilots, Fitz Fulton and Don Mallick. N820NA was finally retired in April 1975 and put on permanent display at Edwards as a symbol of the Flight Research.

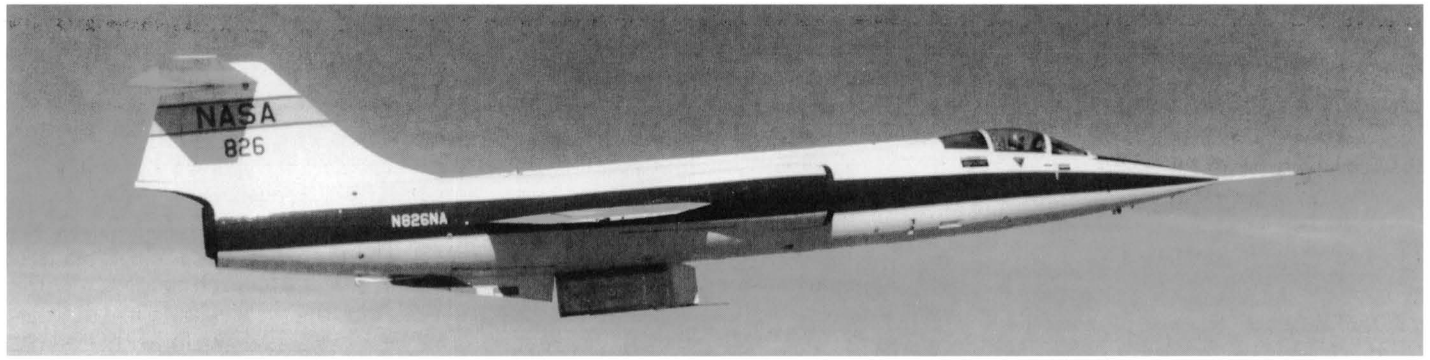
Less than a year later, on 21 April 1978 research pilot John Manke and flight test engineer Ray Young took F-104 N819NA (57–1303) on its final mission, a one-hour crew training flight. During its 18-year-long career N819NA had made 1,730 previous flights. Under the skilful direction of Dr William 'Bill' Winter, this Starfighter had provided data that made a significant impact in the field of biomedical research. Many of the research flights with this F-104 were to acquire flight data on a number of biomedical experiments. Data attained by this aircraft also played a vital role in establishing the Ground Command Guidance system as a valuable flight test tool to be used by the Center.

Two other areas in which the aircraft made important contributions were the development of the low-lift/drag approach and landing patterns used by the X-15 and lifting-body vehicles, as well as the testing of a ballute (cross between a balloon and a parachute) system. This aircraft was a major player in the early work, including night flights, flown to develop and 'standardize' the low-lift/drag approach and landing technique used so successfully in numerous programmes flown at Dryden. The prime ballute experiment involved obtaining data to evaluate a towed high speed decelerator through a Mach number range from 0.7 to approximately 2.0 and a system that could be used to increase the drag of an asymmetrical vehicle.

The ballute was a semi-spherical shaped device, 4ft (1.2m) in diameter, similar to a small balloon that self-inflated with the air picked up by the small air scoops located around its circumference when deployed. It was installed in the drag-chute compartment of the Starfighter and deployed in a manner similar to that of a standard drag chute. Up until these tests, the state-of-the-art research on ballutes was limited to wind-tunnel studies and rocket-flight tests of ballutes behind symmetrical bodies. The F-104 presented a test platform by which the study of the ballute system could be expanded. During its career of more than eighteen years, N819NA flew 1,731 flights and was flown by at least nineteen different pilots (sixteen from Dryden, two from Ames, and one from the Air Force). These included Apollo astronauts and X-15, lifting-body, XB-70A and YF-12 pilots. In June 1983 N819NA was put on display at McClellan AFB, Sacramento, California.

In 1986 the remaining F-104s were still being used as chase and research aircraft, notably as part of the NASA High Alpha Flight Research Program, together with the McDonnell Douglas F-18s which subsequently replaced the Starfighter at Edwards. The last two F-104s, N812NA, and N826NA, were retired by NASA on 3 February 1994. (The following day F-104G/N N812NA arrived at Lockheed Palmdale for static display). Research pilot Tom McMurtry flew the last NASA flight, in F-104G N826NA, making a low-speed and a high-speed fly-by prior to landing in a salute to Dryden employees. The flight, which lasted 29min 45sec, brought to an end more than thirty-seven years and more than 18,200 F-104 Starfighter flights.

**RF-104G-8213 N826NA on a research mission out of the NASA Dryden Flight Research facility at Edwards, California in September 1991. Test articles were attached to a Flight Test Fixture located just forward of the Starfighter's ventral fin and were subjected to a variety of speed and dynamic pressures. The aircraft was used to test an optical air data collection system that used laser light beams to determine speed, angles of attack, and sideslip, and also a luminescent paint to record surface pressures. N826NA was one of the two last NASA F-104s (N812NA was the other), and they were both retired on 3 February 1994.** NASA



APPENDIX I

# Starfighter Chronology

| | |
|---|---|
| *January 1953* | Model 83 design selected by the Pentagon under Weapon System WS-303A |
| *12 March 1953* | Letter Contract AC 33(600)-23362 for two XF-104 prototypes received |
| *30 April 1953* | Mock-up approved |
| *January 1954* | First XF-104 example (c/n 083-1001, serial 53-7786) built in strict secrecy |
| *28 February 1954* | XF-104 53-7786 makes unscheduled short and straight hop |
| *4 March 1954* | 53-7786, first of the two XF-104 prototypes flies for the first time, piloted by Tony LeVier |
| *25 March 1955* | XF-104-2 53-7787, now powered by an afterburning Wright J65-W-7, reaches a top speed of Mach 1.79 (1,324mph/2,130km/h) |
| *30 March 1955* | US Air Force places order for 17 YF-104As against contract AF-27378 |
| *27 April 1955* | Maj Howard C. Johnson powered the XF-104A to Mach 2 for the first time |
| *23 December 1955* | First YF-104A rolled out at Burbank |
| *16 February 1956* | First public roll-out, at Burbank |
| *17 February 1956* | First YF-104A (model 183-93-02) makes maiden flight |
| *28 February 1956* | YF-104A, flown by Joe Ozier, exceeds Mach 2 for the first time |
| *2 March 1956* | Contract received for seven pre-production F-104As and authorises the procurement of 146 F-104As and six F-104Bs for Air Defense command, and, 56 F-104Cs for Tactical Air Command (TAC) |
| *27 April 1956* | YF-104A-LO reaches Mach 2 |
| *26 December 1956* | Lockheed receive a second order from Tactical Air Command, for a further twenty-one F-104Cs |
| *7 February 1957* | F-104B trainer version flies |
| *26 January 1958* | Deliveries of production Starfighters to the USAF begin, to the 83rd Fighter-Interceptor Squadron, Air Defense Command, at Hamilton Field |
| *7 May 1958* | F-104 becomes the first aircraft to hold World Airspeed and Altitude records simultaneously.<br>Maj Howard C. Johnson of the 83rd FIS reaches 91,249ft (27,813m) at Edwards AFB |
| *16 May 1958* | Capt Walter W. Irwin sets a world air speed record of 1,404.19mph (2,259.83km/h) over a 15/25km course at Edwards AFB |
| *24 July 1958* | F-104C (Model 483-04-05) fighter-bomber variant (for Tactical Air Command) flies for first time |
| *October 1958* | Twelve F-104As of the 83rd FIS take part in Operation *Jonah Able* to Taiwan |
| *31 October 1958* | F-104D-LO (Model 383-04-06) flight tested |
| *18 December 1958* | Flying from NAS Point Magu, California, an F-104A sets three time-to-climb records: 3000m (9,842ft) in 41.35sec; 15,000m (49,212ft) in 2 min 11.1sec; and 25,000m (82,020ft) in 4min 26.03sec |
| *18 March 1959* | Herr Franz Josef Strauss, Federal German defence minister, signs contract to begin licence production |
| *17 September 1959* | Canada signs licence production contract to build 200 CF-104 Starfighters |
| *October 1959* | F-104F-LO (Model 483-04-08) handed over to German military officials |
| *14 December 1959* | F-104C 56-0885 piloted by Captain Joe Jordan, Edwards AFB test pilot, beats the previous Starfighter height record, reaching 103,389ft (31,513m)m, thus becoming the first aircraft taking off on its own power to exceed the 30,000m and 100,000ft marks. Hitting a top speed of 1,400mph (2,252.6km/h), the F-104C also established a 30,000m time-to-climb mark of 5min 4.92sec, and even surpassed the existing balloon record of 101,516ft (30,942m) |
| *1959* | For his design work on the aircraft, Johnson receives the prestigious Collier Trophy from the American Institute of Aeronautics and Astronautics |
| *29 January 1960* | Japan signs licensed production contract |
| *22 February 1960* | German flight training in USA commences |
| *24 February 1960* | Oberstleutnant Günther Rall, first of over 2,000 German Starfighter 'student' pilots to solo |
| *20 April 1960* | The Netherlands signs licensed production contract |
| *June 1960* | *JaboG31* 'Böelcke' at Nörvenich first in Germany to receive F-104Gs |
| *7 June 1960* | F-104G-LO (Model 683-10-19) Lockheed-built model (c/n 683-2001) first flown |
| *20 June 1960* | Belgium signs licensed production contract |
| *1960* | F-104 withdrawn from USAF Air Defense Command |
| *late 1960* | First flight of QF-104A drone |
| *1 December 1960* | Starfighter production commences at German plants |
| *February 1961* | US Air Force signs order for Military Assistance Program F-104Gs |
| *2 March 1961* | Italy signs licensed production contract |
| *29 March 1961* | *Luftwaffe* loses its first Starfighter |
| *April 1961* | F-104 logs its 100,000th flight hour |
| *26 May 1961* | CF-104 (CF-111) first flown |
| *30 June 1961* | F-104J (Model 683-07-14) first Lockheed-built F-104J flies |
| *August 1961* | In the presence of *Inspekteur de Luftwaffe*, Gen Josef Kammhuber, the first F-104Gs built by Lockheed are handed over to the *Bundeswehr* |
| *1 November 1961* | During the Berlin Crisis all three ANG F-104 fighter interceptor squadrons activated for deployment to Europe |
| *11 November 1961* | First Starfighter for the *KLu* to be assembled by Fokker, flies |

**Jacqueline Cochran is congratulated by Tony LeVier.**

| | |
|---|---|
| *December 1961* | First German pilot flies a F-104G faster than the speed of sound |
| *25 January 1962* | *Luftwaffe* loses its first pilot killed while flying a Starfighter |
| *20 February 1962* | *JaboG31* declared fully operational |
| *September 1962* | Capt Charles E. Tofferi, 479th Tactical Fighter Wing, piloting a F-104, wins 'William Tell 1962' Fighter Weapons Meet at Nellis AFB |
| *March 1963* | *9° Gruppo CI, 4° Stormo Amendo d'Aosta* becomes first operational *AMI* unit to receive F-104G |
| *July 1963* | First Canadair-built F-14G flies |
| *6 December 1963* | Maj Robert W. Smith in a NF-104A sets an unofficial height record of 118,860ft (36,229m) for aircraft taking off on their own power |
| *1 May 1963* | Flying a TF-104G, Jacqueline Cochran establishes a 100km (62miles) closed circuit world speed record of 1203.686mph (1937.14km/h) near Edwards AFB, CA |
| *11 May and 1 and 3 June 1964* | Flying TF-104G N104L, Jacqueline Cochran sets three women's speed records; 1,429.246mph (2,300.14km/h) over a 15/25km course; 1,303.18mph (2,097.23km/h) over a 100km (62 mile) closed circuit; and 1,127.4mph (1,814.34km/h over a 500km (310.7 mile) course |
| *April 1965* | F-104Cs of the 436th Tactical Fighter Squadron (TFS), 479th Tactical Fighter Wing (TFW) sent to South Vietnam |
| *1968* | Wg Cdr R.A. White RCAF flies a CF-104 to 100,100ft (30,510m) for a new altitude record. The CF-104 also reaches 1,800mph (2,896km/h) for an unofficial record. The estimated ground speed, aided by the jetstream, was Mach 2.7 |
| *October 1966* | F-104J/DJS first enter service in Japan |
| *30 December 1966* | First Lockheed-modified F-104S flown |
| *July 1967* | Last F-104Cs in the USAF inventory transferred to the Air National Guard |
| *1973* | 1,127th and last F-104G delivered, by MBB |
| *31 July 1975* | Last Starfighters in USAF service retired by the ANG's 198th TFS |
| *24 October 1977* | In a special F-104RB called *Red Baron*, which he had built with help from American Jet Industries, Inc of Van Nuys, California, Darryl Greenamyer sets a new world speed record over a 3km course at restricted altitude; 988.26mph (1590.43km/h) at Mud Lake, Tonopah, Nevada. With this aircraft fitted with 2½ft wingtip extensions, Greenamyer failed to set a new world altitude record |
| *March 1979* | The very last Starfighter, the 246th and final Italy-produced F-104S, rolled out. World-wide Starfighter production therefore reached 2,578 |
| *30 April 1983* | *JaboG31* 'Böelcke' gives up its last F-104G |
| *1 August 1983* | *JaboG31* 'Böelcke' becomes the first wing in the *Luftwaffe* to re-form as a Tornado IDS unit |
| *December 1984* | Flight trials of a modernized F-104S ASA demonstrator begin |
| *30 May 1985* | *JaboG33* flies its last Starfighter sortie |
| *1 March 1986* | Last CF-104s phased out of Canadian service by No.441 Squadron at Baden-Söllingen |
| *October 1987* | *JaboG34* last *Luftwaffe* Starfighter operational unit finally retires the F-104G |
| *May 1991* | *Wehrtechnische Dienststelle 61* (*WTD61*) has the honour of flying the last German Starfighter sortie |

## APPENDIX II

# Starfighter Production Totals

Number built: 741 by Lockheed plus 48 co-produced by Lockheed & European consortiimi, 340 by Canadair, 444 by Fiat, 350 by Fokker, 50 by MBB, 210 by Messerschmitt, 207 by Mitsubishi, and 188 by SABCA

| CONSTRUCTION NOS | MODEL | CUSTOMER | SERIAL NOS | NO. |
|---|---|---|---|---|
| 083-1001/1002 | XF-104-LO | USAF | 53-7786/53-7787 | 2 |
| 183-1001/1017 | YF-104-LO | USAF | 55-2955/55-2971 | 17 |
| 183-1018/1024 | F-104A-1-LO | USAF | 56-730/56-736 | 7 |
| 183-1O25/1O35 | F-104A-5-LO | USAF | 56-737/56-747 | 11 |
| 183-1036/1051 | F-104A-10-LO | USAF | 56-748/56-763 | 16 |
| 183-1052/1076 | F-104A-15-LO | USAF | 56-764/56-788 | 25 |
| 183-1077/1113 | F-104A-20-LO | USAF | 56-789/56-825 | 37 |
| 183-1114/1165 | F-104A-25-LO | USAF | 56-826/56-877 | 52 |
| 183-1166/1170 | F-104A-30-LO | USAF | 56-878/56-882 | 5 |
| 283-5000/5005 | F-1048-1-LO | USAF | 56-3719/56-3724 | 6 |
| 283-5006/5014 | F-1045-5-LO | USAF | 57-1294/57-1302 | 9 |
| 283-5015/5023 | F-1045-10-LO | USAF | 57-1303/57-1311 | 9 |
| 283-5024/5025 | F-1045-1 5-LO | USAF | 57-1312/57-1313 | 2 |
| 383-1171/1226 | F-104C-5-LO | USAF | 56-883/56-938 | 56 |
| 383-1227/1247 | F-104C-10-LO | USAF | 57-910/57-930 | 21 |
| 483-5026/5032 | F-104D-5-LO | USAF | 57-1314/57-1320 | 7 |
| 483-5033/5040 | F-1040-10-LO | USAF | 57-1321/57-1328 | 8 |
| 483-5041/5046 | F-104D-15-LO | USAF | 57-1329/57-1334 | 6 |
| 483-5047/5076 | F-104F-LO | *Luftwaffe* | 59-4994/59-5023 | 30 |
| 583A-5301/5338 | CF-104D | RCAF | 12631/12668 | 38 |
| 583B-5401/5420 | F-104DJ | *Koku Jieitai* | 16-5001/16-5020 | 20 |
| 583C-5501/5506 | TF-104G-LO | USAF (MAP) | 61-3025/61-3030 | 6 |
| 583C-5507/5524 | TF-104G-LO | USAF (MAP) | 62-12262/62-12279 | 18 |
| 583C-5525/5528 | TF-104G-LO | USAF (MAP) | 63-12681/63-12684 | 4 |
| 583C-5529 | TF-1040-LO | USAF (MAP) | 65-9415 | 1 |
| 5830-5701 | TF-1044-LO | *Luftwaffe* (MSP) | 61-3031 | 1 |
| 5830-5702 | TF-104G-LO | Co. owned | N104L | 1 |
| 5830-5703/5755 | TF-104G-LO | *Luftwaffe* MSP | 61-3032/61-3084 | 53 |
| 5830-5756/5766 | TF-104G-LO | *Luftwaffe* MSP | 63-8452/63-8462 | 11 |
| 5830-5767 | TF-104G-LO | *AMI* (MAP) | 63-12685 | 1 |
| 5830-5768 | TF-104G-LO | *Luftwaffe* (MAP) | 63-8463 | 1 |
| 5830-5769 | TF-104G-LO | *AMI* (MAP) | 63-12686 | 1 |
| 5830-5770/5771 | TF-104G-LO | *Luftwaffe* (MAP) | 63-8464/63-8465 | 2 |
| 5830-5772 | TF-104G-LO | *AMI* (MAP) | 63-12687 | 1 |
| 5830-5773 | TF-104G-LO | *Luftwaffe* (MAP) | 63-8466 | 1 |
| 5830-5774 | TF-104G-LO | *AMI* (MAP) | 63-12688 | 1 |
| 5830-5775 | TF-104G-LO | *Luftwaffe* (MSP) | 63-8467 | 1 |
| 5830-5776 | TF-104G-LO | *AMI* (MAP) | 63-12689 | 1 |
| 5830-5777 | TF-104G-LO | *Luftwaffe* (MSP) | 63-8468 | 1 |
| 5830-5778 | TF-104G-LO | *AMI* (MAP) | 63-12690 | 1 |
| 5830-5779 | TF-104G-LO | *Luftwaffe* (MSP) | 63-8469 | 1 |
| 5830-5780/5785 | TF-104G-LO | *AMI* (MAP) | 63-12691/63-12696 | 6 |
| 5830-5786/5788 | TF-104G-LO | *FAé* (MSP) | 64-15104/64-15106 | 3 |
| 583E-5801/5813 | TF-104G-LO | *KLu* | D-5801/D-5813 | 13 |
| 583E-5814/5817 | TF-104G-LO | *KLu* (co-prod) | D-5814/D-5817 | 4 |
| 583F-5901/5932 | TF-104G-LO | *Luftwaffe* | KF201/KF232 | 32 |
| 583F-5933/5942 | TF-104G-LO | *Luftwaffe* | 66-1 3622/66-13631 | 10 |
| 583F-5943/5965 | TF-104G-LO | *Luftwaffe* (co-prod) | KE201/KE223 | 23 |
| 583G-5101/5109 | TF-104G-LO | *FAé* (co-prod) | FC-04/FC-12 | 9 |
| 583H-5201/5212 | TF-104G-LO | *AMI* (co-prod) |  | 12 |
| 683-2001/2009 | F-104G-LO | *Luftwaffe* | KF101/KF109 | 9 |
| 683-2010 | F-104G-LO | *Luftwaffe* | 63-1 3259 | 1 |
| 683-2011/2016 | F-104G-LO | *Luftwaffe* | 63-13230/63-13235 | 6 |
| 683-2017 | F-104G-LO | *Luftwaffe* | KF117 | 1 |
| 683-2018 | F-104G-LO | *Luftwaffe* | 63-13236 | 1 |
| 683-2019 | F-104G-LO | *Luftwaffe* | KF199 | 1 |
| 683-2020/2028 | F-104G-LO | *Luftwaffe* | 63-13237/63-13245 | 9 |
| 683-2029 | F-104G-LO | *Luftwaffe* | KF129 | 1 |
| 683-2030/2042 | F-104G-LO | *Luftwaffe* | 63-13246/63-13258 | 13 |
| 683-2043/2050 | F-104G-LO | *Luftwaffe* | KF143/KF150 | 8 |
| 683-2051 | F-104G-LO |  |  | 1 |
| 683-2052/2075 | F-104G-LO | *Luftwaffe* | KF151/KF174 | 24 |
| 683-2076 | F-104G-LO | *Luftwaffe* | 63-13260 | 1 |
| 683-2077/2085 | F-104G-LO | *Luftwaffe* | KF176/KF184 | 9 |
| 683-2086 | F-104G-LO | *Luftwaffe* | 63-13262 | 1 |
| 683-2087/2090 | F-104G-LO | *Luftwaffe* | KF186/KF189 | 4 |
| 683-2091/2093 | F-104G-LO | *Luftwaffe* | 63-13263/63-13265 | 3 |
| 683-2094 | F-104G-LO | *Luftwaffe* | KF193 | 1 |
| 683-2095/2097 | F-104G-LO | *Luftwaffe* | 63-13266/63-13268 | 3 |
| 683- | F-104G-LO | Pattern a/c for Italy | MM6501 | 1 |
| 683- | F-104G-LO | Pattern a/c for Belgium | 63-13274 | 1 |
| 6838-3001/3003 | F-104J | *Koku Jieitai* | 26-8501/26-8503 | 3 |
| 683C4001/4023 | F-104G-LO | Greece/Turkey (MAP) | 61-2601/61-2623 | 23 |
| 683C-4024 | RF-104G-LO | Greece (MAP) | 61-2624 | 1 |
| 683C-4025/4033 | RF-104G-LO | Norway (MAP) | 61-2625/61-2633 | 9 |
| 683C-4034/4044 | RF-104G-LO | (MAP) | 62-12232/62-12242 | 11 |
| 683C-4045 | F-104N-LO | NASA | 811 | 1 |
| 683C-4046/4052 | RF-104G-LO | (MAP) | 62-12243/62-12249 | 7 |
| 683C-4053 | F-104N-LO | NASA | 812 | 1 |
| 683C-4054/4057 | RF-104G-LO | (MAP) | 62-12250/62-12253 | 4 |
| 683C-4058 | F-104N-LO | NASA | 813 | 1 |
| 683C-4059/4066 | RF-104G-LO | (MAP) | 62-12254/62-12261 | 8 |
| 683C-4067/4084 | F-104G-LO | (MAP) | 62-12214/62-12231 | 18 |

LICENCE-BUILT STARFIGHTERS

*CANADAIR*

|  |  |  |  |  |
|---|---|---|---|---|
| 1001/1200 | CF-104 | RCAF | 12701/12900 | 200 |
| 6001/6048 | F-104G | (MAP) | 62-12302/62-12349 | 48 |
| 6049/6086 | F-104G | (MAP) | 62-12697/62-12734 | 38 |
| 6087/6096 | F-104G | (MAP) | 63-13638/63-13641 | 10 |
| 6097/6140 | F-104G | (MAP) | 64-17752/64-17795 | 44 |

*FIAT*

|  |  |  |  |  |
|---|---|---|---|---|
| 6502/6599 | F-104G | *AMI* | MM6502/M146599 | 98 |
| 6600 | F-104G | *Luftwaffe* | KC101 | 1 |
| 6601 | F-104G | *AMI* | MM6601 | 1 |
| 6602 | F-104G | *Luftwaffe* | KC102 | 1 |
| 6603 | F-104G | *AMI* | MM6603 |  |
| 6604/6607 | F-104G | *Luftwaffe* | KC103/KC106 | 4 |
| 6608/6611 | F-104G | *AMI* | MM6608/MM6611 | 4 |
| 6612/6620 | F-104G | *Luftwaffe* | KC107/KC115 | 9 |
| 6621/6630 | RF-104G | *Luftwaffe* | KC116/KC125 | 10 |
| 6631/6638 | F-104G | *AMI* | MM6631/MM6638 | 8 |
| 6639/6642 | RF-104G | *Luftwaffe* | KC126/KC129 | 4 |

| CONSTRUCTION NOS | MODEL | CUSTOMER | SERIAL NOS | NO. |
|---|---|---|---|---|
| 6643/6651 | F-104G | *AMI* | MM6643/MM6651 | 9 |
| 6652/6651 | F-104G | *KLu* | D-6652/D-6657 | 6 |
| 6658/6660 | F-104G | *AMI* | MM6658/MM6660 | 3 |
| 6658 | F-104S | *AMI* | MM6658 | (1) |
| 6660 | F-104S | *AMI* | MM6660 | (1) |
| 6661/6665 | RF-104G | *Luftwaffe* | KC130/KC134 | 5 |
| 6666/6671 | F-104G | *KLu* | D-6666/D-6671 | 6 |
| 6672/6679 | RF-104G | *Luftwaffe* | KC135/KC142 | 8 |
| 6680/6685 | F-104G | *KLu* | D-6680/D-6685 | 6 |
| 6686/6693 | RF-104G | *Luftwaffe* | KC143/KC150 | 8 |
| 6694/6700 | F-104G | *KLu* | D-6694/D-6700 | 7 |
| 6701/6850 | F-104S | *AMI* | MM6701/MM6850 | 150 |
| 6851/6868 | F-104S | Turkish AF |  | 18 |
| 6869/6883 | F-104S | *AMI* | MM6869/MM6883 | 15 |
| 6884/6889 | F-104S | Turkish AF |  | 6 |
| 6890 | F-104S | *AMI* | MM6890 | 1 |
| 6891/6896 | F-104S | Turkish AF |  | 6 |
|  | F-104S | *AMI* |  | 39 |
|  | F-104S | Turkish AF |  | 10 |
| *FOKKER* |  |  |  |  |
| 8001 | F-104G | *Luftwaffe* | KG101 | 1 |
| 8002/8003 | F-104G | *Luftwaffe* | 63-13269/63-13270 | 2 |
| 8004/8006 | F-104G | *Luftwaffe* | KG104/KG106 | 3 |
| 8007/8009 | F-104G | *Luftwaffe* | 63-13271/63-13273 | 3 |
| 8010/8012 | F-104G | *Luftwaffe* | KG110/KG112 | 3 |
| 8013 | F-104G | *KLu* | D-8013 | 1 |
| 8014/8020 | F-104G | *Luftwaffe* | KG114/KG120 | 7 |
| 8021 | F-104G | *Luftwaffe* | 64-12746 | 1 |
| 8022 | F-104G | *KLu* | D-8022 | 1 |
| 8023/8044 | F-104G | *Luftwaffe* | KG123/KG144 | 22 |
| 8045 | F-104G | *KLu* | D-8045 | 1 |
| 8046 | F-104G | *Luftwaffe* | KG146 | 1 |
| 8047/8053 | F-104G | *KLu* | D-8047/D-8053 | 7 |
| 8054/8055 | F-104G | *Luftwaffe* | KG154/KG155 | 2 |
| 8056 | F-104G | *Luftwaffe* | 63-13229 | 1 |
| 8057/8063 | F-104G | *KLu* | D-8057/D-8063 | 7 |
| 8064 | F-104G | *Luftwaffe* | 64-12749 | 1 |
| 8065/8066 | F-104G | *KLu* | D-8065/D-8066 | 2 |
| 8067/8069 | F-104G | *Luftwaffe* | 64-12750/64-12752 | 3 |
| 8070 | F-104G | *Luftwaffe* | KG170 | 1 |
| 8071 | F-104G | *Luftwaffe* | 64-12753 | 1 |
| 8072/8076 | F-104G | *Luftwaffe* | KG172/KG176 | 5 |
| 8077 | F-104G | *Luftwaffe* | 64-12754 | 1 |
| 8078/8081 | F-104G | *Luftwaffe* | KG178/KG181 | 4 |
| 8082/8084 | F-104G | *KLu* | D-8082/D-8084 | 3 |
| 8085/8087 | RF-104G | *Luftwaffe* | KG185/KG187 | 3 |
| 8088 | F-104G | *Luftwaffe* | KG188 | 1 |
| 8089/8091 | F-104G | *KLu* | D-8089/D-8091 | 3 |
| 8092 | F-104G | *Luftwaffe* | KG192 | 1 |
| 8093 | F-104G | *KLu* | D-8093 | 1 |
| 8094/8095 | RF-104G | *Luftwaffe* | KG194/KG195 | 2 |
| 8096/8097 | F-104G | *Luftwaffe* | KG196/KG197 | 2 |
| 8098/8099 | F-104G | *KLu* | D-8098/D-8099 | 2 |
| 8100 | F-104G | *Luftwaffe* | KG200 | 1 |
| 8101 | RF-104G | *KLu* | D-8101 | 1 |
| 8102 | RF-104G | *Luftwaffe* | KG202 | 1 |
| 8103 | RF-104G | *KLu* | D-8103 | 1 |
| 8104/8105 | F-104G | *KLu* | D-8104/D-8105 | 2 |
| 8106 | RF-104G | *Luftwaffe* | KG206 | 1 |
| 8107 | RF-104G | *KLu* | D-8107 | 1 |
| 8108 | RF-104G | *Luftwaffe* | KG208 | 1 |
| 8109/8110 | F-104G | *KLu* | D-8109/D-8110 | 2 |
| 8111 | RF-104G | *Luftwaffe* | KG211 | 1 |
| 8112 | RF-104G | *KLu* | D-8112 | 1 |
| 8113 | RF-104G | *Luftwaffe* | KG213 | 1 |
| 8114/8115 | F-104G | *KLu* | D-8114/D-8115 | 2 |
| 8116 | RF-104G | *Luftwaffe* | KG216 | 1 |
| 8117 | RF-1040 | *KLu* | D-8117 | 1 |
| 8118 | RF-104G | *Luftwaffe* | KG218 | 1 |
| 8119 | RF-104G | *KLu* | D-8119 | 1 |
| 8120/8121 | F-104G | *KLu* | D-8120/D-8121 | 2 |
| 8122 | RF-104G | *Luftwaffe* | KG222 | 1 |
| 8123 | RF-104G | *KLu* | D-8123 | 1 |
| 8124 | RF-104G | *Luftwaffe* | KG224 | 1 |
| 8125 | RF-104G | *KLu* | D-8125 | 1 |
| 8126 | RF-104G | *Luftwaffe* | KG226 | 1 |
| 8127 | RF-104G | *KLu* | D-8127 | 1 |
| 8128 | RF-104G | *Luftwaffe* | KG228 | 1 |
| 8129 | RF-104G | *KLu* | D-8129 | 1 |
| 8130 | RF-104G | *Luftwaffe* | KG230 | 1 |
| 8131 | RF-104G | *KLu* | D-8131 | 1 |
| 8132 | RF-104G | *Luftwaffe* | KG232 | 1 |
| 8133 | RF-104G | *KLu* | D-8133 | 1 |
| 8134 | RF-104G | *Luftwaffe* | KG234 | 1 |
| 8135 | RF-104G | *KLu* | D-8135 | 1 |
| 8136/8137 | RF-104G | *Luftwaffe* | KG236/KG237 | 2 |
| 8138 | RF-104G | *KLu* | D-8138 | 1 |
| 8139/8140 | RF-104G | *Luftwaffe* | KG239/KG240 | 2 |
| 8141 | RF-104G | *KLu* | D-8141 | 1 |
| 8142 | RF-104G | *Luftwaffe* | KG242 | 1 |
| 8143 | RF-104G | *KLu* | D-8143 | 1 |
| 8144 | RF-104G | *Luftwaffe* | KG244 | 1 |
| 8145 | RF-104G | *KLu* | D-8145 | 1 |
| 8146 | RF-104G | *Luftwaffe* | KG246 | 1 |
| 8147 | RF-104G | *KLu* | D-8147 | 1 |
| 8148/8161 | RF-104G | *Luftwaffe* | KG248/KG261 | 14 |
| 8162 | F-104G | *Luftwaffe* | KG262 | 1 |
| 8363/8165 | RF-104G | *Luftwaffe* | KG263/KG265 | 3 |
| 8166 | F-104G | *Luftwaffe* | KG266 | 1 |
| 8167 | RF-104G | *Luftwaffe* | KG267 | 1 |
| 8168/8170 | F-104G | *Luftwaffe* | KG268/KG270 | 3 |
| 8171 | RF-104G | *Luftwaffe* | KG271 | 1 |
| 8172 | F-104G | *Luftwaffe* | KG272 | 1 |
| 8173/8174 | RF-104G | *Luftwaffe* | KG273/KG274 | 2 |
| 8175 | F-104G | *Luftwaffe* | KG275 | 1 |
| 8176 | RF-104G | *Luftwaffe* | KG276 | 1 |
| 8177 | F-104G | *Luftwaffe* | 67-14893 | 1 |
| 8178 | F-104G | *Luftwaffe* | KG278 | 1 |
| 8179/8181 | RF-104G | *Luftwaffe* | KG279/KG281 | 3 |
| 8182 | F-104G | *Luftwaffe* | KG282 | 1 |
| 8183 | F-104G | *Luftwaffe* | 63-13690 | 1 |
| 8184/8187 | F-104G | *Luftwaffe* | KG284/KG287 | 4 |
| 8188 | F-104G | *Luftwaffe* | 63-13691 | 1 |
| 8189/8190 | F-104G | *Luftwaffe* | KG289/KG290 | 2 |
| 8191/8192 | RF-104G | *Luftwaffe* | 67-14890/67-14891 | 2 |
| 8193/8195 | F-104G | *Luftwaffe* | KG293/KG295 | 3 |
| 8196 | F-104G | *Luftwaffe* | 63-13261 | 1 |

| CONSTRUCTION NOS | MODEL | CUSTOMER | SERIAL NOS | NO. |
|---|---|---|---|---|
| 8197/8203 | F-104G | *Luftwaffe* | KG297/KG303 | 7 |
| 8204 | RF-104G | *Luftwaffe* | 67-14890 | 1 |
| 8205/8206 | RF-104G | *Luftwaffe* | KG305/KG306 | 2 |
| 8207 | F-104G | *Luftwaffe* | KG307 | 1 |
| 8208/8211 | RF-104G | *Luftwaffe* | KG308/KG311 | 4 |
| 8212 | F-104G | *Luftwaffe* | KG312 | 1 |
| 8213/8215 | RF-104G | *Luftwaffe* | KG313/KG315 | 3 |
| 8216 | F-104G | *Luftwaffe* | KG316 | 1 |
| 8217/8219 | RF-104G | *Luftwaffe* | KG317/KG319 | 3 |
| 8220 | F-104G | *Luftwaffe* | KG320 | 1 |
| 8221/8223 | RF-104G | *Luftwaffe* | KG321/KG323 | 3 |
| 8224 | F-104G | *Luftwaffe* | KG324 | 1 |
| 8225/8227 | RF-104G | *Luftwaffe* | KG325/KG327 | 3 |
| 8228 | F-104G | *Luftwaffe* | KG328 | 1 |
| 8229/8230 | RF-104G | *Luftwaffe* | KG329/KG330 | 2 |
| 8231 | F-104G | *Luftwaffe* | KG331 | 1 |
| 8232/8233 | RF-104G | *Luftwaffe* | KG332/KG333 | 2 |
| 8234 | F-104G | *Luftwaffe* | KG334 | 1 |
| 8235/8236 | RF-104G | *Luftwaffe* | KG335/KG336 | 2 |
| 8237 | F-104G | *Luftwaffe* | KG337 | 1 |
| 8238/8242 | RF-104G | *Luftwaffe* | KG338/KG342 | 5 |
| 8243/8245 | F-104G | *KLu* | D-8243/D-8245 | 3 |
| 8246/8249 | RF-104G | *Luftwaffe* | KG346/KG349 | 4 |
| 8250 | F-104G | *Luftwaffe* | KG350 | 1 |
| 8251/8255 | RF-104G | *Luftwaffe* | KG35I/KG355 | 5 |
| *SABCA* | | | | |
| 9002/9005 | F-104G | *Luftwaffe* | 63-13275/63-13278 | 4 |
| 9006/9015 | F-104G | *Luftwaffe* | KH106/KH115 | 10 |
| 9016/9024 | F-104G | *FAé* | FX-1/FX-9 | 9 |
| 9025/9026 | F-104G | *Luftwaffe* | KH116/KH117 | 2 |
| 9027/9029 | F-1046 | *FAé* | FX-10/FX-12 | 3 |
| 9030/9031 | F-104G | *Luftwaffe* | KH118/KH119 | 2 |
| 9032/9034 | F-104G | *FAé* | FX-13/FX-15 | 3 |
| 9035/9037 | F-104G | *Luftwaffe* | KH120/KH122 | 3 |
| 9038/9040 | F-104G | *FAé* | FX-16/FX-18 | 3 |
| 9041/9043 | F-104G | *Luftwaffe* | KH123/KH125 | 3 |
| 9044/9046 | F-104G | *FAé* | FX-19/FX-21 | 3 |
| 9047/9049 | F-104G | *Luftwaffe* | KH126/KH128 | 3 |
| 9050/9052 | F-104G | *FAé* | FX-22/FX-24 | 3 |
| 9053/9055 | F-104G | *Luftwaffe* | KH129/KH131 | 3 |
| 9056/9058 | F-104G | *FAé* | FX-25/FX-27 | 3 |
| 9059/9061 | F-104G | *Luftwaffe* | KH132/KH134 | 3 |
| 9062/9064 | F-104G | *FAé* | FX-28/FX-30 | 3 |
| 9065/9067 | F-104G | *Luftwaffe* | KH135/KH137 | 3 |
| 9068/9073 | F-104G | *FAé* | FX-31/FX-36 | 6 |
| 9074/9076 | F-104G | *Luftwaffe* | KH138/KH14O | 3 |
| 9077/9079 | F-104G | *FAé* | FX-37/FX-39 | 3 |
| 9080/9081 | F-104G | *Luftwaffe* | KH141/KH142 | 2 |
| 9082 | F-104G | *FAé* | FX-27 | 1 |
| 9083/9109 | F-104G | *FAé* | FX-40/FX-66 | 27 |
| 9110/9112 | F-104G | *Luftwaffe* | KH143/KH145 | 3 |
| 9113/9115 | F-104G | *FAé* | FX-67/FX-69 | 3 |
| 9116/9118 | F-104G | *Luftwaffe* | KH146/KH148 | 3 |
| 9119/9121 | F-104G | *FAé* | FX-70/FX-72 | 3 |
| 9122/9124 | F-104G | *Luftwaffe* | KH149/KH151 | 3 |
| 9125/9127 | F-104G | *FAé* | FX-73/FX-75 | 3 |
| 9128/9130 | F-104G | *Luftwaffe* | KH152/KH154 | 3 |

| CONSTRUCTION NOS | MODEL | CUSTOMER | SERIAL NOS | NO. |
|---|---|---|---|---|
| 9131/9133 | F-104G | *FAé* | FX-76/FX-78 | 3 |
| 9134/9136 | F-104G | *Luftwaffe* | KH155/KH157 | 3 |
| 9137/9142 | F-104G | *FAé* | FX-79/FX-84 | 6 |
| 9143/9145 | F-104G | *Luftwaffe* | KH158/KH160 | 3 |
| 9146/9148 | F-104G | *FAé* | FX-85/FX-87 | 3 |
| 9149/9151 | F-104G | *Luftwaffe* | KH161/KH163 | 3 |
| 9152/9154 | F-104G | *FAé* | FX-88/FX-90 | 3 |
| 9155/9157 | F-104G | *Luftwaffe* | KH164/KH166 | 3 |
| 9158/9160 | F-104G | *FAé* | FX-91/FX-93 | 3 |
| 9161/9163 | F-104G | *Luftwaffe* | KH167/KH169 | 3 |
| 9164/9166 | F-104G | *FAé* | FX-94/FX-96 | 3 |
| 9167/9169 | F-104G | *Luftwaffe* | KH170/KH172 | 3 |
| 9170/9172 | F-104G | *FAé* | FX-97/FX-99 | 3 |
| 9173/9175 | F-104G | *Luftwaffe* | KH173/KH175 | 3 |
| 9176 | F-104G | *FAé* | FX-100 | 1 |
| 9177/9189 | F-104G | *Luftwaffe* | KH176/KH188 | 13 |
| 8256/8260 | F-104G | *KLu* | D-8256/D-8260 | 5 |
| 8261/8262 | RF-104G | *Luftwaffe* | KG361/KG362 | 2 |
| 8263 | F-104G | *Luftwaffe* | KG363 | 1 |
| 8264/8265 | RF-104G | *Luftwaffe* | KG364/KG365 | 2 |
| 8266/8268 | F-104G | *KLu* | D-8266/D-8268 | 3 |
| 8269/8271 | RF-104G | *Luftwaffe* | KG369/KG371 | 3 |
| 8272/8273 | F-104G | *KLu* | D-8272/D-8273 | 2 |
| 8274 | RF-104G | *Luftwaffe* | KG374 | 1 |
| 8275 | F-104G | *Luftwaffe* | KG375 | 1 |
| 8276 | RF-104G | *Luftwaffe* | KG376 | 1 |
| 8277/8278 | F-104G | *Luftwaffe* | KG377/KG378 | 2 |
| 8279/8283 | F-104G | *KLu* | D-8279/D-8283 | 5 |
| 8284/8285 | F-104G | *Luftwaffe* | KG384/KG385 | 2 |
| 8286 | F-104G | *KLu* | D-8286 | 1 |
| 8287 | F-104G | *Luftwaffe* | KG387 | 1 |
| 8288 | F-104G | *KLu* | D-8288 | 1 |
| 8289/8292 | F-104G | *Luftwaffe* | KG389/KG392 | 4 |
| 8293/8294 | F-104G | *KLu* | D-8293/D-8294 | 2 |
| 8295/8296 | F-104G | *Luftwaffe* | KG395/KG396 | 2 |
| 8297 | F-104G | *KLu* | D-8297 | 1 |
| 8298/8299 | F-104G | *Luftwaffe* | KG398/KG399 | 2 |
| 8300 | F-104G | *KLu* | D-8300 | 1 |
| 8301/8303 | F-104G | *Luftwaffe* | KG401/KG403 | 3 |
| 8304 | F-104G | *KLu* | D-8304 | 1 |
| 8305/8307 | F-104G | *Luftwaffe* | KG405/KG407 | 3 |
| 8308 | F-104G | *KLu* | D-8308 | 1 |
| 8309/8310 | F-104G | *Luftwaffe* | KG409/KG410 | 2 |
| 8311/8312 | F-104G | *KLu* | D-8311/D-8312 | 2 |
| 8313/8317 | F-104G | *Luftwaffe* | KG413/KG417 | 5 |
| 8318/8319 | F-104G | *KLu* | D-8318/D-8319 | 2 |
| 8320/8323 | F-104G | *Luftwaffe* | KG420/KG423 | 4 |
| 8324/8326 | F-104G | *KLu* | D-8324/D-8326 | 3 |
| 8327/8330 | F-104G | *Luftwaffe* | KG427/KG430 | 4 |
| 8331/8332 | F-104G | *KLu* | D-8331/D-8332 | 2 |
| 8333/8335 | F-104G | *Luftwaffe* | KG433/KG435 | 3 |
| 8336/8338 | F-104G | *KLu* | D-8336/D-8338 | 3 |
| 8339/8340 | F-104G | *Luftwaffe* | KG439/KG440 | 2 |
| 8341/8343 | F-104G | *KLu* | D-8341/D-8343 | 3 |
| 8344/8350 | F-104G | *Luftwaffe* | KG444/KG450 | 7 |
| 7301/7314 | F-104G | *Luftwaffe* | 2641/2654 | 14 |
| 7401/7436 | F-104G | *Luftwaffe* | 2655/2690 | 36 |

| CONSTRUCTION NOS | MODEL | CUSTOMER | SERIAL NOS | NO. |
|---|---|---|---|---|
| *MESSERSCHMITT* | | | | |
| 7001 | F-104G | *Luftwaffe* | 64-12745 | 1 |
| 7002/7006 | F-104G | *Luftwaffe* | KE302/KE306 | 5 |
| 7007 | F-104G | *Luftwaffe* | 67-14888 | 1 |
| 7008/7014 | F-104G | *Luftwaffe* | KE308/KE314 | 7 |
| 7015 | F-104G | *Luftwaffe* | 67-14889 | 1 |
| 7016/7022 | F-104G | *Luftwaffe* | KE316/KE322 | 7 |
| 7023 | F-104G | *Luftwaffe* | 67-14886 | 1 |
| 7024/7038 | F-104G | *Luftwaffe* | KE324/KE338 | 15 |
| 7039 | F-104G | *Luftwaffe* | 64-12748 | 1 |
| 7040/7097 | F-104G | *Luftwaffe* | KE340/KE397 | 58 |
| 7098 | F-104G | *Luftwaffe* | 64-12747 | 1 |
| 7099/7119 | F-104G | *Luftwaffe* | KE399/KE419 | 21 |
| 7120 | F-104G | *Luftwaffe* | 66-13524 | 1 |
| 7121/7131 | F-104G | *Luftwaffe* | KE421/KE431 | 11 |
| 7132/7133 | F-104G | *Luftwaffe* | 66-13525 & 67-14885 | 2 |
| 7134/7176 | F-104G | *Luftwaffe* | KE434/KE476 | 43 |
| 7177 | F-104G | *Luftwaffe* | 63-13526 | 1 |
| 7178/7210 | F-104G | *Luftwaffe* | KE478/KE510 | 33 |
| | | | | |
| *MITSUBISHI* | | | | |
| 6835-3001/3003 | F-104J | *Koku Jieitai* | 26-8501/26-8503 | (3) |
| 6835-3004/3007 | F-104J | *Koku Jieitai* | 26-8504/26-8507 | 4 |
| 6835-3008/3063 | F-104J | *Koku Jieitai* | 36-8508/36-8563 | 56 |
| 6835-3064/3158 | F-104J | *Koku Jieitai* | 46-8564/46-8658 | 95 |
| 6835-3159/3180 | F-104J | *Koku Jieitai* | 56-8659/56-8680 | 22 |
| 6835-3181/3210 | F-104J | *Koku Jieitai* | 76-8681/76-8710 | 30 |

APPENDIX III

# Starfighter Operators World-Wide

| | Belgium | Canada | Denmark | Germany | Greece | Italy | Japan | Jordan | NASA | Netherlands | Norway | Pakistan | Spain | Taiwan | Turkey | USAF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lockheed F-104A | | (1) | - - | - - | < | - - | - - | (32) | (4) | < | - - | (10) | < | (46) | < | 153 |
| Lockheed F-104B | | | | | | | | (4) | - - | < | - - | (2) | < | (8) | < | 26 |
| Lockheed F-104C | | | | | | | | | | | | | | | | 77 |
| Lockheed F-104D | | | | | | | | | | | | | | (6) | < | 21 |
| Lockheed 104DJ (Japan) | | | | | | | 20 | - - | - - | > | - - | - - | - - | (5) | | |
| Lockheed F-104G/Euro | | | | 87 | | | | | | | 1 | | | (73)[5] | | |
| Lockheed F-104G/MDAP | | | | | 3 | | | | (3) | | | | | | 21[3] | |
| Lockheed RF-104G | | | | | | | | | | | 2 | | | (25)[7] | (2) | |
| Lockheed TF-104G/Euro | 12 | | | 146 | (22) | 24(6) | | | | 18 | 2 | | | (49)[6] | (31) | |
| Lockheed TF-104G/MDAP | | | 4 | | 5+(1[1]) | | | | (3) | | | | 3 | | 4 | |
| Lockheed F-104F | | | | 30 | | | | | | | | | | | | |
| Lockheed F-104J/Japan | | | | | | | 210 | - - | - - | > | - - | - - | - - | (27)[8] | | |
| Lockheed F-104N | | | | | | | | | 3 | | | | | | | |
| Canadair CF-104D | | 38 | (7) | - - | - - | > | - - | > | - - | - - | (4) | - - | > | - - | (6) | |
| Canadair F-104G/MDAP | | | 25 | | | 50(inc 9[1]) | | | | | 16 | | 18 | (42) | 11+(20) | |
| Canadair CF-104 | | 200 | (15) | - - | - - | > | - - | > | - - | - - | (18) | - - | > | - - | (44) | |
| Fiat F-104G | | | | 50[2] | (10[2]) | 125 | | | | 25 | - - | - - | > | - - | (20) | |
| Fiat F-104S | | | | | | 205 | | | | | | | | | 40 | |
| Fokker F-104G | | | | 255[4] | (3) | | | | | 77 | - - | - - | > | - - | (25) | |
| Fokker RF-104G | | | | | (16) | | | | (1) | 19 | - - | - - | > | - - | (18) | |
| Messerschmitt F-104G | | | | 210 | (49) | | | | | | | | | | (120) | |
| MBB F-104G | | | | 50 | | | | | | | | | | | | |
| SABCA F-104G | 101 | | | 87 | | | | | | | | | | | (17) | |
| **TOTALS** | **113** | **239** | **51** | **916** | **159** | **360** | **230** | **36** | **14** | **139** | **43** | **12** | **21** | **281** | **379** | **277** |

1 Transferred from Spain
2 From Netherlands
3 61-2602/2608 and 61-2610/2623
4 inc. 1 from *KLu*
5 including 37 from the *Luftwaffe*, 14 from Belgium (used for spare parts only), and three from Turkey
6 including 27 ex-*Luftwaffe* machines. Nine ex-Belgian Air Force (used for spare parts only)
7 including three ex-*Luftwaffe* aircraft
8 five of the F-104Js were used for spare parts

# Notes

## INTRODUCTION

1 Sampson, A., *The Arms Bazaar* (Hodder & Stoughton, 1977)

2 Sampson, *The Arms Bazaar*

3 Sharman, S., *Sir James Martin* (PSL, 1996)

4 Sharman, *Sir James Martin*

5 Sampson, *The Arms Bazaar*

6 Sampson, *The Arms Bazaar*

7 By comparison, of the 334 English Electric Lightnings built for the Royal Air Force, some 109 examples were lost or written off – *see Bowman, M.W., EE Lightning* (Crowood, 1997)

8 Bowman, *EE Lightning*

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9 Gunston, B. *Early Supersonic Fighters of the West*

10 *See* Bowman, M.W., *English Electric Lightning* (Crowood, 1997)

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11 Strauss, F. –J., 'Those Wonderful Men in the Cactus Starfighter Squadron', (Los Angeles Litton Industries, 1976)

12 Spick, M., *Luftwaffe Fighter Aces* (Ivy Books, 1996)

13 James P. Fitzgerald

14 'Missile from Mojave' *Airpower*, Machat, M., July 1993

15 Machat, 'Missile from Mojave'

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16 Fitzgerald, J.P., *Lockheed Test Program*

17 Fitzgerald, *Lockheed Test Program*

18 Fitzgerald, *Lockheed Test Program*

19 Fitzgerald, *Lockheed Test Program*

20 Reed, A., *Modern Combat Aircraft 9: F-104 Starfighter* (Ian Allan Ltd, 1981)

## CHAPTER 7

21 To eject safely from the Starfighter the pilot's feet had to be retracted into the stirrups of the seat. To assure proper foot retention and retraction on ejection the pilot wore foot spurs equipped with ball sockets at the back. The ball lock end, engaged by spurs, was attached to cables that pulled feet rearward and secured them in foot shelf units. Two initiators, fired one second apart, cut the cables free at the proper time

## CHAPTER 8

22 Sqn Ldr Devayya was posthumously awarded the *Maha Vir Chakra* in 1988, 23 years after the war, when Indian authorities learnt of the IAF pilot's valour through an account of the encounter in John Fricker's *Battle for Pakistan* (1978)

## CHAPTER 9

23 Thompson, M.O. and C.P. Crecy, (Crècy, 1999)

24 Yeager, C. and Leo Janos, *Yeager* (Bantam, 1985)

25 Yeager and Janos, *Yeager*.

26 Thompson and Crècy, *Flying without Wings*

27 Thompson and Crècy, *Flying without Wings*

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***Lockheed F-104 Starfighter*** is the story of the 'missile with a man in it', Lockheed's Mach 2 interceptor, that served across the world for over thirty years.

**Martin W. Bowman** has assembled a fine collection of photographs and produced a lively and informative text on this impressive and sometimes misunderstood aeroplane.

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